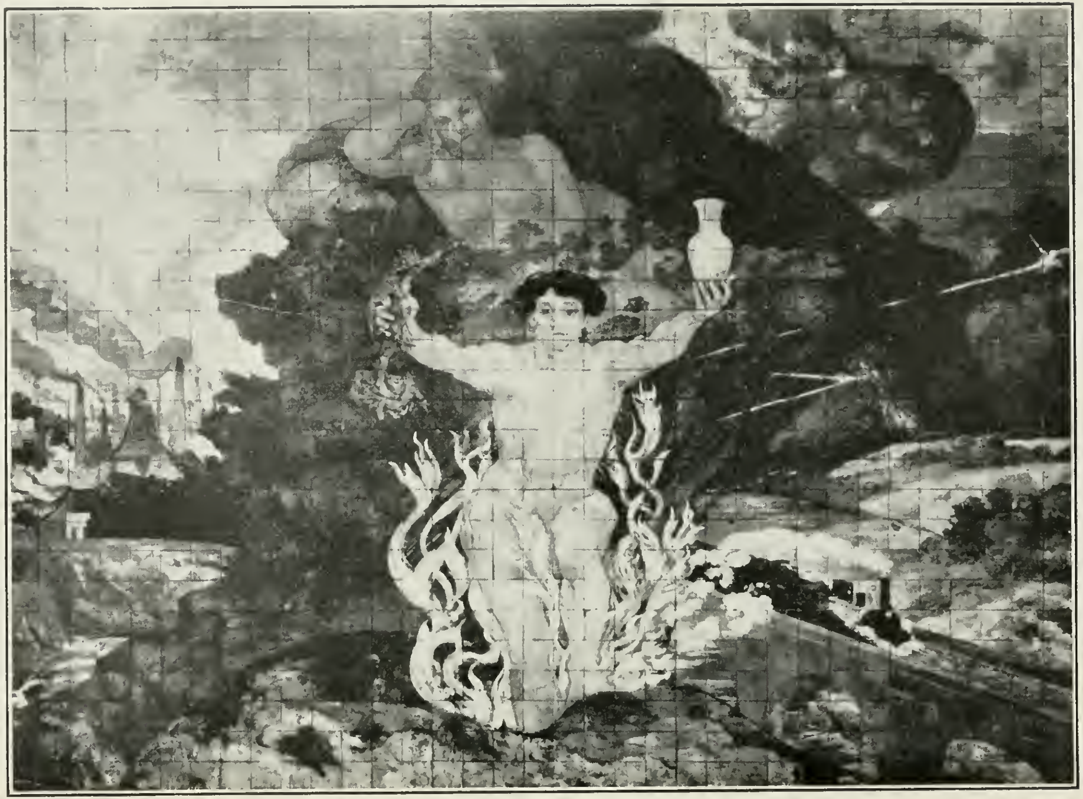
FOR·THE·INCREASE·
·AND·DIFFVSION·OF
·KNOWLEDGE·AMONG·MEN·
PER
ORBEM
·SMITHSONIAN·
·INSTITVTION·
·WASHINGTON·1846·

SHOUT
SHARE
IT



WATER AND FIRE. ENCAUSTIC TILE PAINTING, LIMOGES, FRANCE

Designed by Bracquemond for Haviland and Company

FOR DESCRIPTION OF PLATE SEE PAGE XI

SMITHSONIAN INSTITUTION
UNITED STATES NATIONAL MUSEUM
Bulletin 139

FIRE AS AN AGENT IN HUMAN CULTURE

BY

WALTER HOUGH
Head Curator of Anthropology, United States National Museum

WASHINGTON
GOVERNMENT PRINTING OFFICE
1926

ADDITIONAL COPIES
OF THIS PUBLICATION MAY BE PROCURED FROM
THE SUPERINTENDENT OF DOCUMENTS
GOVERNMENT PRINTING OFFICE
WASHINGTON, D. C.
AT
50 CENTS PER COPY

ADVERTISEMENT

The scientific publications of the National Museum include two series, known, respectively, as *Proceedings* and *Bulletin*.

The *Proceedings*, begun in 1878, is intended primarily as a medium for the publication of original papers, based on the collections of the National Museum, that set forth newly acquired facts in biology, anthropology, and geology, with descriptions of new forms and revisions of limited groups. Copies of each paper, in pamphlet form, are distributed as published to libraries and scientific organizations and to specialists and others interested in the different subjects. The dates at which these separate papers are published are recorded in the table of contents of each of the volumes.

The *Bulletin*, the first of which was issued in 1875, consists of a series of separate publications comprising monographs of large zoological groups and other general systematic treatises (occasionally in several volumes), faunal works, reports of expeditions, catalogues of type-specimens, special collections, and other material of similar nature. The majority of the volumes are octavo in size, but a quarto size has been adopted in a few instances in which large plates were regarded as indispensable. In the *Bulletin* series appear volumes under the heading *Contributions from the United States National Herbarium*, in octavo form, published by the National Museum since 1902, which contain papers relating to the botanical collections of the Museum.

The present work forms No. 139 of the *Bulletin* series.

Alexander Wetmore,
Assistant Secretary, Smithsonian Institution.

Washington, D. C., November 8, 1926.

TABLE OF CONTENTS

Page
Preface xi
Predilection for heat 1
Fireless peoples 2
Fire preservation 2
Ignition point 4
Ignition in nature 5
Transportation 7
Biological factor 7
Location of the fire 8
Rudiments of invention in the fireplace 11
Fire in architecture 13
Heating appliances for special uses 14
Laying the fire 18
Development of fire tools and furnishings of the fireplace 19
Development of draught 22
Bellows 24
Braziers 26
Flue stoves 28
Cooking 30
Stone boiling 40
Boiling 44
Development of the cooking stove 46
Fuel 53
Fire in archeological research 58
Smoke and fire signals 58
Fire hunting 60
Clearing and agriculture 65
Technology 67
Metallurgy 74
Ceramics 75
Baths 76
Sanitation 79
War 81
Fire alarms and prevention 82
Time by light and fire 83
Fire making by artificial means 84
Ethnography of the fire drill 85
Ethnography of the fire saw 104
Ethnography of the fire thong 106
Ethnography of the fire plow 107
Ethnography of the fire piston 109
The strike-a-light 111
Ethnography of flint and pyrites 111
Ethnography of the flint and steel strike-a-light 114
Ethnography of the bamboo strike-a-light 119

Page

Lens and mirror 119
Ethnography of tinder 12
Matches 123
Fire gods 126
Fire worship 128
Priests 131
Altars 132
Offerings 132
Sacrifice 133
Incense 134
New fire 138
Perpetual fire 142
Strange fire and pure fire 143
Bonfires, etc 144
Lightning—Superstitions and customs 144
Rain making 152
Marriage fire 153
Origin myths 156
Communal fire and social organization 165
Borrowing 166
Fire in mortuary observances 167
Cremation 168
Ordeal 170
Purification 173
Superstitious healing 174
Fire walking 176
Pyromancy 182
Illumination 184
Fireflies 195
Torch and candle 198
Candles 208
Development of the lamp 217
Ethnography of the lamp 224
Float lamp 238
Lamps of antiquity 239
Electric light 244
Gas 245
Civic lighting 245
Illuminants 246
Light in cult 249
Index 257

LIST OF ILLUSTRATIONS

PLATES

Facing page
1. Water and Fire. Encaustic tile painting, Limoges, France. Designed by Bracquemond for Haviland & Co ---- Title
2. Stone rests in ancient fireplace, New Mexico, top; trivet bosses of baked clay and method of using, middle; and ancient pit-house fireplace, New Mexico, bottom ---- 12
3. (1) Pottery hot-water bottle, with depressions for the feet ---- 13
   (2) Italian scaldino or ambulant stove.
   (3, 4) Chinese hand warmers.
   (5) Kachmerian wicker hand stove.
4. Hand warmers and foot warmers. Top, western China; middle, Flemish; and bottom, United States ---- 18
5. American Indian tongs ---- 19
   (1, 2) Pair of Kiowa crotch-stick tongs.
   (3) Apache, Arizona.
   (4) Havasupai, Arizona.
   (5) Washoes, Nevada.
   (6) Fire-borrowing tongs, Denmark.
   (7, 8) Spanish pincer tongs.
6. Fire fans ---- 24
   (1) Paraguay.
   (2) Merida, Mexico.
   (3) Yucatan.
   (4) Cape Blanco, Morocco.
   (5) Spain.
   (6) Ecuador.
7. Primitive valve bellows, Gaboon, Africa ---- 25
8. Braziers. Top, Durango, Mexico; middle, Spain; and bottom, China. This massive bronze brazier was used by candidates undergoing the official examinations at Peking ---- 24
9. Spits and grid of the Powhatan Indians, Virginia. (From model) ---- 25
10. Baking slabs of pottery and stone ---- 40
   (1) Tetuan, Morocco.
   (2, 3) Soapstone dish and slab, the latter ancient from California.
   (4) Stones for stone boiling, Lower California, Mexico.
   (5) Pottery tortilla baker, Mexico.
11. Paunch on tripod for stone boiling, Teton Sioux ---- 41
12. Rice steamer, Simalur Island, East Indies ---- 40
13. Simple stoves ---- 41
   (1, 2) Stove and pot rest, Philippines.
   (3) Double brazierlike stove with legs, Philippines.
   (4) Brazierlike stove from Laos, French Indo-China.
   (5) Pot stove with legs, Phillppines.
   (6) Pottery stove with high pot rests, Philippines.
   (7) Stove pierced on side, Tetuan, Morocco.

Facing page
14. Elaborate range with primitive installation, Philippines 50
15. Pottery stoves of simple type. Top, bowl stove with suggested draft, Mexico; middle, pottery stove with encircling wall and hearth, Mexico; and bottom, inclosed stove with no draft, Mexico. 50
16. Portable and fixed stoves with draft 50
    (1) Bowl with side cut out, Java.
    (2–6) Stove models with grate, Mexico, Spain, Porto Rico, Mexico, Venezuela.
    (7) Tibetan stove with flue.
    (8) Stove from Jogo Kebu, Africa.
    (9) Stove from Philippines.
17. Pottery stoves with rudimentary draft and with grate. Left, Philippines, and right, Santa Lucia, West Indies 50
18. Pottery stove with grate, Portugal 50
19. Pottery arcaded front stoves with pots and shovel, from Etruscan site at Sovana, Italy, third century, B. C 50
20. Metal stoves from Morocco, Africa 50
21. Cast-Iron stoves with grate. Top, Pennsylvania, and bottom, San Francisco whaling ships 50
22. Fixed stoves, portable stoves, and aboriginal ovens 50
    (1) Three-hole stove with simple draft, Mexico.
    (2) Fixed stove, Mexico.
    (3) Korean soapstone cooking pot.
    (4) Korean soapstone stove.
    (5) Korean cooking bowl used in frying meat.
    (6) Hopi Indian field oven, Arizona.
    (7) Hopi Indian mush oven, Arizona.
23. Japanese kitchen range with simple open-door draft 50
24. Eastern Indians spearing fish by torchlight. (Model) 64
25. Fishing with torch and dip net, New England; torching fish into a net with a floating lantern, New England 65
26. Angola native blacksmith at work, using a two-phase bellows 74
27. Sources of fire in nature and primitive camp fire. Top, volcano in action; middle, lightning setting fire to a forest; and bottom, carrying fire from one camp to another 75
28. Fire making by means of the drill. Top, the mouth-set bow drill, Eskimo; bottom, with the simple two-stick drill; widespread 96
29. Fire making with the strap drill and pump drill. Top, Eskimo; bottom, Iroquois Indians 97
30. Fire making with the fire saw and plow. Top, Eastern Asia; bottom, Polynesia 110
31. Fire pistons for igniting tinder by air compression 111
    (1) Siam.
    (2) Lower Siam.
    (3) Philippine Islands.
    (4) Philippine Islands.
    (5) Java.
32. Firefly lanterns. Top, West Indies; bottom, Java 198

Facing page
33. Types of torches. Torches of resin 199
  (1) Borneo healing torch.
  (2) Karens, Burma.
  (3) Lower Siam.
  (4) Mindanao, Philippine Islands.
  (5) Porto Rico, West Indies.
  (6) Gaboon, Africa.
  (7) Lower Siam.
  (8) Singapore.
  (9) Mass of fat on a stick, Mongolia.
  (10) Fancifully wound taper, Virginia.
  (11) Link, Spain.
  (12) Mass of resin on stick, West Africa.
  (13) Candle-tree bark for torch, Mexico.
  (14) Fat-pine torch material, Virginia.
34. Splint and candle holders 214
  (1) Finland.
  (2) Device for splint and candle, Finland.
  (3) Splint holder for staff, Czechoslovakia.
  (4) Splint holder with weighted arm, England.
  (5) Candle and splint holder, England.
35. Candleholders of various types 214
  (1) Wooden candlestick, Finland.
  (2) Branched candlestick, Finland.
  (3) Pricket processional iron candlestick, Europe, fifteenth century.
  (4) Iron candlestick, Pennsylvania.
  (5) Spring candlestick, 1709, Germany.
36. Perforated iron lantern, United States 216
  Perforated copper lantern, Italy.
  Lantern "Guy Fawkes" with horn panes, England.
37. Development of the lamp in simple forms 216
38. Development of the lamp in advanced forms, to electric lamp 216
39. Shell lamp and hanging saucer float lamp. Top, Orkney Islands; bottom, Tetuan, Morocco 216
40. Lamps showing types of development from the simpler lamps 224
  (1) Crusie of brass.
  (2) Ancient Roman pottery lamp with simple handle and beak.
  (3) Ancient Roman lamp without handle and with beak.
  (4) Saracenic green glazed lamp with wick gutter, Egypt.
  (5) Saucer lamp with rudimentary handle and wick channel, Ceylon.
  (6) Crusie of hammered iron, Scotland.
  (7) Simple saucer lamp on stand, China.
  (8) Majolica lamp showing pinched-in saucer, Italy.
41. Lamps of metal with limited and complete gravity pressure 225
  (1) Argand type lamp, England.
  (2) Italian brass lucerna.
  (3) Dutch brass-spout lamp.
  (4) Kyal lamp, Cape Cod, Massachusetts.
  (5) Kerosene lamp with tubular wick, 1876. United States.

PREFACE

This work undertakes to present the salient features of an encyclopaedic subject in a more or less condensed fashion. The importance of this study of heating and illumination is thought to be its contribution to the history of culture as connected with the inventiveness displayed by man in the adaptation of the primary natural key force nearest to his needs in all the earlier stages of progress. The history also suggests the intellectual, esthetic, and religious reactions marking the several stages of culture gradually attained by man.

In the treatment of this subject the chief consideration is given to the earlier steps in the utilization of fire. The later stages marked by the proliferation of the modern period do not call for more than casual attention.

Classification.—Heating and illumination are the grand divisions of the subject. These comprehend all the topics relating to the uses of fire. Under heating are included applications of fire to warming the body, the house, cooking, smelting, timbering, healing, decoration, to cult, and numerous other uses. Under illumination are the application of light to a myriad purposes, from utilitarian to the highest phases of esthetic and religious ideas.

Nearest of the energies of the universe and the greatest within the range of man's needs is fire. Wind and water are also primitive approaches to natural energies, but these change nothing while fire is a transforming agent (pl. 1).

"What are the most brilliant of our chemical discoveries compared with the invention of fire and the metals?"—Disraeli.

"Fire, greatest of discoveries, enabling man to live in various climates, use many foods, and compel the forces of nature to do his work.

"Electricity, carrier of light and power, devourer of time and space. Bearer of human speech over land and sea, greatest servant of man, itself unknown."[1]

Because of the intimate connection of fire with the culture growth of humanity, whatever relates to the antiquity of the use of fire must be of peculiar value in the history of early progress. Anthropological science finds evidences of the fire art in the ancient traces of man where relics of his arts have not been disturbed. Even the man whose stone implements are distributed in the gravels is believed to have known the use of fire. Such an unbroken line running through thousands of years admits of a study of the development of an art so intimately connected with man's progress under unusual conditions.

---

[1] Inscription on Union Station, Washington, D. C., selected by Dr. Charles W. Eliot and approved by Woodrow Wilson.

In this subject are encountered traces, sometimes clear and again obscure, of the deeper currents of our history which mark the beginning and accompany the development of our connection with nature. It is evident that fire was the first abnormal phenomenon striking man, and that it was the first natural force which he consciously used. Without fire it is difficult to imagine how most of the early arts would have been possible, and no one needs to be reminded of the extent to which the present arts and sciences depend on this agency. It may be shown also that fire in time has exerted a modifying influence on man more radical than has been suspected.

There is some data, more or less reliable, on the psychology of the higher primates in respect to fire. Purchas quaintly says: "The people of the countrie, when they travaile in the woods make fire when they sleep in the night; and in the morning when they are gone the Pongoes will come and sit about the fire till it goeth out; for they have no understanding to lay the wood together."[2]

Man has possessed fire so long that the inquiry as to whether it is a human characteristic has some point. And the question is: Shall we then extend the use of fire to other primates than man? It is evident that of all animals primates are the only species who could undertake the task of caring for fire. As a deduction from the leverage of fire possession shall we say that here began the elevation of the primates toward man?

Definitely, the first traces of fire associated with human remains were found with the Ehringsdorf jaw, where charcoal occurs with flint implements. Only two finds, the Piltdown and Mauer (Heidelberg) are older. The Ehringsdorf man dates from either the Mousterian, Acheulian, or Chellean. As Dr. George G. MacCurdy observes, in any case in the Riss-Würm interglacial period.[3] Dr. Ales Hrdlicka informs me that European archeologists place the first traces of fire of human origin in the Acheulian.

The discussion of the beginnings of the fire art requires the utilization of all the resources which the science of man affords, and even the use of the scientific imagination as an aid. The difficulties which surround the subjects are insurmountable so far as setting forth authoritative conclusions are concerned. It has always been a free field for speculation, however, attracting philosophic minds of all times.

---

[2] Purchas his Pilgrimes, 1619, chap. 3, sec. 6.

[3] Human Origins, 1924, vol. 1, p. 348.

One fact stands clearly forth, namely, that no remains of man's arts show him without fire as an ally; therefore, whatever the antiquity of such finds, we have no other data as to the antiquity of the use of fire. Back of these finds we may assume logically that there was a period when man was without fire, and that in the subdivisions of this period he first saw fire in its natural manifestations. Second, he made use of fire derived from some source in nature, and third, invented some method of making it at will.

There are several sources which have been suggested as applying to primitive conditions. These are fire from volcanoes or igneous action, from chemical reactions producing fire in coal seams, from earthquakes producing landslides igniting trees by friction, from wind incited friction of tree branches and bamboo jungles, and from lightning. These are natural occurrences within the observation of early man, but it forces the scientific imagination too much to conclude that such material suggestions by themselves were consciously taken up by anyone. Early man was not an Edison to appraise the salient points of nature. It is nearer to earth to imagine that man got his knowledge of wood-friction heat by a series of more or less conscious observations during a long period of working in wood and vegetable fibers. This is conceived to have been a long process devoid of brilliant analogical deductions, but advancing at times quite rapidly toward the goal. It is reasonably stated that man was acquainted with fire and used fire derived from nature long before he invented a process for making fire artificially. Granted that in some of his work with wood he observed a heat, a vapor with odor, or smoke, even a coal of fire from rubbing, cutting, or boring by primitive methods, the further steps look easy. That further progress is not easy is shown by the following requirements: 1, Not many kinds of wood are suitable for the simple drill or fire saw; 2, suitable tindery material in which to increase the spark must be found; 3, the trap for the fire is a slot or channel cut in the horizontal piece of wood and is itself a great discovery; 4, a coal of fire can be nursed to a blaze only with great skill and knowledge. These are merely the chief difficulties of an invention which as it stands would seem miraculous did we not know that it is a growth and the culmination of a long research by primitive scientists.

Three phases of association with nature may be generalized from what is conjectured and observed of the course of development of man. These are;

1. Dependence on nature,
2. Beginning interdependence of man and nature, growing toward
3. Independence now observed in certain lines and pointing out the goal of ultimate achievement.

To express broadly the history of man and fire we have: 1, Man fireless, hypothetical stage; 2, man adopts fire; 3, man develops fire and himself; 4, man invents the firestick; and 5, man inherits the earth.

FIRE AS AN AGENT IN HUMAN CULTURE

By WALTER HOUGH

Head Curator of Anthropology, United States National Museum

PREDILECTION FOR HEAT

One of the characteristics which man shares with many animals is an appreciation of warmth. Humboldt remarks that in all climates people show the same predilection for heat.[1] Fire was as necessary to the Indians of Guiana as to Arctic peoples, by day and night. Everyone has a fire under his hammock, kept up with great attention. In the huts the fire is built on a clay hearth laid on the floor.[2]

This feature is cared for by clothing, habitation, and other matter reflecting the natural adaptation to environment and antedating the use of artificial warming, which begins with fire. In all phases of man's development is evinced a fondness for hot springs, which early were visited for the advantages of warmth, and to which later were attributed healing powers, and later still became resorts of luxury. "Long before European settlers saw New Zealand the thermal and mineral waters attracted the natives, who had discovered their curative properties."[3] In this connection it is surmised that the use of hot water as a drink for the purpose of adding to the heat of the body became appreciated at an early time, followed by the general use of hot food and drink after the utilization of fire. It may be seen that much was learned as to the properties of heat from warm springs before the domestication of fires.

Another primitive example to which attention has not heen called is the use of the warmth of animals. It has been observed that animal societies show innumerable adaptations in response to the reaction stimuli of cold. This reaction extends also through humanity. The close association of man with domestic animals at an early period suggests a warmth utility which explains the surviving traces of such association into the present, giving rise to good-humored ridicule of people who lived somewhat primitively.

---

[1] Travels and Researches, Edinburgh, 1832, ed. 4, p. 154.

[2] Schomburgh. Hakluyt Society, London, 1848, p. 50.

[3] Henry M. Cadell. New York Sun, November, 1900.

Gen. James M. Ashton informs me that the reindeer herds of the Chukchi and Chuvanes of Siberia are tended by the young folks, who are sometimes caught out in devastating blizzards. In such an exigency two deer are made to lie down side by side, back to the wind, and the herder creeps between them and weathers the gale between his warm hosts. Incidentally, deer are made to lie down by a gentle kick on the shin of the hind leg.

The Kamtschadales are said to use dogs as bedfellows for warmth. Frequent observations go to show that many tribes in the region of seasonal cold regulate their habits in consonance with the seasonal environment. Variety in the seasons renders life in northern latitudes more expansive and tends to develop expedients meeting the needs of each period of the year.

FIRELESS PEOPLES

From time to time there have appeared in the accounts of travelers stories about fireless peoples. When other observers seek to verify these stories they are proven to be without foundation. Not only is fire knowledge a characteristic of all historic races, but as far back as the search for early man has been carried he is found to possess this faithful ally. Much of the misconception giving rise to stories of fireless peoples is due to the habits of some tribes as to the preservation of fire. In some cases it is the custom to carefully preserve fire, so that an observer, though he may remain a long time, is not likely to see an example of renewing fire by artificial methods.

FIRE PRESERVATION

This important section of the fire subject presents some of the most interesting examples of the ingenuity of man. It must, however, be confined to those classes which will give a comprehensive view of the primitive technology, bearing on development, and take up more extensively the use of fire in the ceramic arts, metallurgy, and other arts of enormous consequence to civilization.

With the acquisition of natural fire we have the beginning of a technic regarding its preservation. The question of an adequate and suitable fuel supply comes up at once. If the acquirement of fire is to be regarded as a blessing to mankind, the burden which its care threw upon man represents a heavy price. The primitive industry in feeding the fire is the beginning of the enormous fuel industries of to-day. It is apparent also that the preservation of fire became a subject of invention to relieve the cares of fuel gathering as much as guarding against the loss of fire, which has been customarily assigned as the cause of preservation.

Hints of the methods which may have been employed in early times are given by fire-preservation customs observed in various parts of the world among uncivilized peoples. One of the most suggestive is practiced by the Andamans, who are regarded as belonging to the lower races. In the Andaman Islands they hollow out a large trunk of a tree, then set it on fire and leave the wood to consume little by little. The ashes accumulate and the fire remains there covered up.[4]

The Cherokees buried fire in the ground and kept it for indefinite periods. They secured a tindery log and buried it in the mounds under the council house.[5] The fire cache was also found among the Natchez and Creek Tribes, and was probably general among the eastern and southern Indians.

Primitive methods were also adopted in carrying about small portions of fire, the principal being the slow combustion of wood or fiber. The natives of Matabut Islands, New Guinea, press a quantity of the soft fibrous husk of the ripe coconut into a coconut shell and then place a red-hot ember in the center. This will smoulder for three or four days, and from it the natives obtain light for their cooking fires at any place they may land on their voyage.[6]

The Osage Indians carried fire in fungus tinder from the inside of a hollow tree inclosed in earth and placed between the two valves of a mussel shell. The shell was wrapped up carefully and bound with cord. In this way fire could be kept for several days.[7]

A modern instance was communicated by F. S. Dellenbaugh, of New York, who stated that the fishermen of Concarneau, off Cape Finisterre, carried in their fishing boats a fire horn. This consists of a cow's horn having a stopper in the open end. When the fisherman desires a light he removes the stopper, blows for a moment in the horn, when a blaze appears, from which he lights his pipe. He stops the horn again and throws it under the bow of the boat, where it remains until again needed. Mr. Dellenbaugh did not ascertain what substance retained the fire in the horn, but it is supposed to be decayed wood or material of a fungus. The fire horn is an interesting example of the methods of fire preservation in the period before matches, or possibly even before flint and steel were devised.

The Tehuelche of Patagonia carried fire on the march in earthenware pots having holes in the bottom.[8] This method seems to indicate a crude idea of ventilation of the fire, which will be noticed in the section on stoves.

Another widespread method is observed in the slow match. Among the Pueblos, ancient and modern, cedar bark tied in bundles was found a good medium for preserving fire. The Hopi Indians' fire sticks were usually accompanied with a cedar-bark kopichoki.[9] Other tribes also used the slow match. Numbers of cedar-bark slow matches were in a prehistoric fire temple at Mesa Verde, Colorado.[10] Such slow matches formed a convenient means of distributing the new fire when it had been secured by friction. Australians carry with them a cone of *Banksia*, which burns slowly like amadou.[11]

---

[4] Monat's Adventures and Researches, London, 1863.

[5] Information by James Mooney.

[6] Wilfred Powell. Wanderings in a Wild Country, London, 1883, p. 196.

[7] Information by Francis La Flesche, June 9, 1921. See also 27th Ann. Rep., Bur. Amer. Ethnol., p. 457.

[8] John B. Hatcher. The Indians of Patagonia, Nat. Geog. Mag., vol. 12, 1891, No. 1.

Chinese joss sticks may be a method of preserving fire. The slow match is a spill of soft paper which when lighted gives a momentary flame. This is blown out and the spill glows for a considerable time. When a light is wanted a dexterous puff relights it. They are called *pei hu*, a word close to the sound made in blowing up the spill.

Preservation of the fire overnight was effected with the curfew, "fire cover," those surviving being cones of sheet brass having a few perforations and a handle. The curfew resembles a candle extinguisher, but larger and more squat. The old custom was on retiring to rake the coals in the fireplace together and set over the pile the curfew, which preserved the fire till the morning.

The needs of war, hunting, and travel must have developed innumerable ways for the preserving and transportation of fire. These methods are unrecorded and only little information can be derived from present customs. Nevertheless, the few instances appear to cover possible methods.

The above examples also show the scope of the improvements in fire preservation beyond the earliest practice of preserving coals in the ashes of the camp fire.

IGNITION POINT

It is a wise provision of nature that the ignition point of material is adjusted high and that the approximation of a substance with low ignition to live fire or a spark is unusual. Directed by human intelligence this feature of the fire art became of the greatest importance, having grown step by step from observations and experimentations since early times. It was early observed that charred wood ignites more easily than uncharred; thus charcoal ignites at 580° F. and pine wood at 800° F. Tenuous vegetal material ignites easily and some forms ignite with a flash. The bearing of this on the selection of tinder is evident as the observation on charcoal upon the making of fire by wood friction.

---

[9] Walter Hough. The Hopi Indian Collection in the United States National Museum., Proc. U. S. Nat. Mus., vol. 54, 1918, p. 242.

[10] J. Walter Fewkes. Fire Worship of the Hopi Indians, Ann. Rep., Smith. Inst., 1920, p. 608.

[11] Dumont D'Urville, Voyage, Paris, 1834, vol. 1, p. 94.

IGNITION IN NATURE

Natural ignitions may be divided into volcanic, chemical, electrical, frictional due to earth movements, and frictional on wood. Dioptric ignitions, which are observed in the mechanical ages in connection with glass, would be of the rarest occurrence in nature. Stories as to fortuitous solar ignition through ice must be received with incredulity.

The widespread volcanic activity following certain well-defined belts and areas could furnish the major source of fire for man. The attendant phenomena, such as the burning of forests, beds of cooling lava, hot springs, etc., might well have been within the experience of early man. When the place of origin of man shall be fixed more definitely conclusions will be possible on this subject. At earlier periods within the assigned stage of man volcanic activity was more prevalent than in later periods.

Chemical ignitions in nature have frequently been recorded, and in a majority of cases connected with veins of coal spontaneously fired. Veins of coal having an excess mineral content are more subject to ignition than purer veins. The cause of ignition appears to be the decomposition of pyrites forming sulphates in the presence of loosely aggregated carbon. Spontaneous combustion of coal dust in piles or bins is not explained, but may be due to the occlusion of gases, as in spongy platinum. The rising of the fire in the ground-off charred dust, which is a feature of the fire drill, seems to have such explanation. Smouldering seams of brown coal have been observed in New Zealand.[12] Beds of lignite along the banks of the Mackenzie River a few miles above Bear River have been burning for a long time, and the natives explain the origin of this fire by the tale of Beaver who emptied a dish of grease on his fire and told it to burn and never go out.[13] Carl Bock writes that near Long Wai, Borneo, there is a burning hill that is a coal formation on fire, and has been so since the memory of man.[14] One of the seams of coal in Monongalia County, West Virginia, is subject to "burn outs," which have occurred at some former time and have become naturally extinguished. It is frequently asserted that such coal burnings were started by lightning, and it is also suggested that Indian camp fires on the outcrop is a cause, but there is little evidence in the locality mentioned to substantiate these explanations. Pallas recounts such a fire so occurring in trans-Ural Russia:

"Many persons then living remembered the storm during which a thunderbolt fell upon a great pine tree, which, taking fire and burning rapidly to the very roots, kindled the mountain, which had thenceforth continued on fire. The neighboring forests were wholly consumed by the conflagration. At this time the fire seemed to have retired into the center of the mountain, where it raged with prodigious violence, occasionally bursting forth through the wide fissures * * *.

---

[12] Julius Haas. Moas and Moa Hunters. (Baird pamphlets in Smithsonian Library.)

[13] Frank Russell. Athabascan Myths, Journ. Amer. Folk Lore, vol. 13, No. 48, January-March, 1900, p. 16.

[14] Head Hunters of Borneo, p. 84.

"The view of the volcano (?) during a stormy night was sublime * * *."[15]

All forests have been touched by fire at some time in their history. There is also an unequal distribution of lightning over the earth, and some localities show great prevalence of electrical discharges. In the Santa Rita Mountains in Arizona 30 to 50 per cent of trees were struck and many show firing.[16] Around Forestdale ruin on the White Mountain Apache Reservation in Arizona the writer observed an unusual number of trees which had been killed by lightning.

Lightning is a most prolific cause of ignition in nature. Since the establishment of forest reserves in the United States it has been found that lightning is a source of great damage to the timbered areas. In 1925, 60 per cent of the fires in the national forests originated from lightning. An observer saw nine different fires started by storm lightning in half an hour.[17]

Lightning fires are a common experience in many parts of the of the world, and are the subject of many customs and observances noted in another section. It is believed that lightning was more prevalent in the glacial period than now.[18]

Lightning is thought to have furnished one of the sources from which ancient man derived fire, and there is much in the suggestion. An examination of the myths and customs connected with fire from lightning shows that such fire was utilized for cult purposes (p. 144).

Chance ignitions in nature are sometimes caused in an unusual way. It was observed that many fires were started by falling boulders dislodged by an earthquake which occurred in Arizona in 1887.[19]

Col. R. G. Woodthorpe, investigating the cause of jungle fires, writes: "I asked Captain Raike's Burmese servant how these fires originated. He said, 'At this time of the year the ground is covered with dead leaves and dry grass; rocks roll from above onto others below and strike sparks, which set light to the inflammable dry vegetation.' We were inclined to pooh-pooh this explanation, but further questioning of other entirely independent witnesses always elicited the same reply."[20]

---

[15] Peter Simon Pallas. St. John, Lives of Celebrated Travellers, New York, 1835, vol. 3, p. 77.

[16] J. C. Blemmer. The Plant World, vol. 13, February, 1910, pp. 42-44.

[17] R. H. D. Boerker. Our National Forests, New York, 1918, pp. 124-125.

[18] Information by Dr. W J McGee.

[19] George Goodfellow, U. S. Geological Survey, reported in Popular Science News, June, 1888.

[20] Explorations in Burma, Proc. Roy. Geog. Soc., April, 1889, vol. 11, p. 210.

Tremendous friction is set up in forests during high winds, and under proper conditions it is possible that fires may be started in this manner. Such occurrences must be unusual, and it is found difficult to procure a reliable observation on the subject. Francois Bernier in 1663, traveling in Cashmere, observed:

"Some of the trees were scorched and burnt, either blasted by the thunderbolt, or, according to the traditions of the peasantry, set on fire in the heat of summer by rubbing against each other when agitated by fierce, burning winds."[21]

TRANSPORTATION

In the transportation of fire we see the beginning of many inventions. Fire on the hearth has a place well understood, but when fire has to be moved precautions must be taken to carry it safely and without danger. For ordinary distances a brand from the fire or a coal or some inflammable medium lighted at the fire is sufficient. For carrying small amounts of fire longer time and distances the various means are discussed on page 3. The transportation of fire bodily is shown by the Virginia Indian canoe fire depicted by John White, artist with the Raleigh expedition under John Smith in 1585. Also among the Fuegians the bottom of the canoe has in one place a layer of clay on which a fire is always kept burning.[22] Admiral Charles Wilkes remarks that among the natives of New South Wales a fire is commonly carried upon a layer of gravel in the middle of the boat, and points out that this custom arises either from a natural or superstitious reluctance to be without fire at any time, and that in this they resemble the Fuegians.[23] Attention is called to this profound observation which brings out the almost instinctive association of man with fire.

BIOLOGICAL FACTOR

Fire as a biological factor opens up a subject that has not had the attention it deserves. Since the earliest times fire has evidently been one of the agencies aiding in the displacement and perhaps modification of the habits of animals and plants. Indian myths as to the changes in the animals who tried to catch the sun or who stole fire may have more interesting scientific parallels. In a discussion some years ago on the formation of the American prairies it was brought forward that in former times these lands were forested, and also pretty generally agreed that their treelessness is due to fire. It has been asserted that small prairie animals which give evidence of former arboreal habits now burrow in the ground. The statement in this connection is held untenable by Gerrit S. Miller, of the

---

[21] St. John, Lives of Celebrated Travellers, New York, 1835, vol. 1, p. 225

[22] Charles Pickering. Races, New York, 1819, p. 9.

[23] Wilkes Explorations, Washington, 1850, vol. 2, p. 193.

National Museum, who was consulted on this point. Mr. Miller also suggests that it is more likely in the case of fire clearing that species were exterminated or forced to another environment, and that other species spread into the denuded area. There is a popular opinion in New Zealand that the moa were destroyed by fire from an eruption of Tongarioo which swept over the country.[24] The denuding of the prairies was important in the increase of the Buffalo. The establishment of prairie sod and distribution of species and the composition of societies of its grassy flora was also a consequence.[25]

Col. R. I. Dodge says that the Indians in their great autumn hunts set fire to the prairie to signal their friends that they had found buffalo, or with the object of more effectually bringing the animals together by limiting their feeding grounds, thus reducing the labor of the hunt.[26]

The clearing of the prairies also influenced the distribution and habits of Indian tribes, facilitating agriculture in which sod removal was profitable on account of the richness of the soil. (See Agriculture.)

If, as appears probable, forests have been swept by fire at intervals throughout their history, it is likely that there has been established in some tree species a resistance to the effects of heat. There may be seen in the thickening of the bark near the ground perhaps a protective device. In general, the damage of forest fires is related to the amount of litter on the forest floor and the species of trees. Young replacement growth in most cases suffer.

It has been observed that in conifers whose habit is to produce resistant cones almost prohibiting the release of seed, as in the lodgepole pine, fire is termed essential to the dissemination of the seed.[27]

LOCATION OF THE FIRE

The situation of the fire in the primitive ages necessarily must have been varied. The idea to be kept in mind is a fire unattended with even the minor adaptations which have grown toward the fireplace, the stove, and the myriad inventions for locating, carrying, and generally utilizing fire, which are treated herein in their proper classification. The fire may thus have been placed in front of the rock shelter or cave, as observed in many stations, or in some relation to a camp. The extemporaneous fireplace can hardly be imagined, since the very possession of fire entails responsibilities as to care and preservation which predetermined a well-considered plan to keep the fire. The prearchitectural period thus requires the placing of the fire in an agreed location for the convenience and other requirements of the social unit, considering also not only the benefits but the danger of fire.

---

[24] Julius Haas. Moas and Moa Hunters, 1871, p. 7.

[25] J. Ç. Blemmer. The Plant World, vol, 13, February, 1910, pp. 42–44.

[26] Hunting ground of the Great West, New York, 1877, p. 29.

[27] Tower Gordon in Proc. Soc. of Amer. Foresters, vol. 4, 1909, p. 1.

In view of the early inculcated methods of preserving the fire over periods of time and the small number of uses, it is not probable that early man required much fire. The reproach of the Indian that the white man uses a great heap of wood to cook his food, while the Indian uses only a few sticks, is a case in point. Economy of fuel is characteristic of uncivilized man.

A Sioux lodge at Fort Laramie, Wyoming, is thus described in 1846:

"Their lodges are constructed of poles, erected in a conical shape, for a framework, over which is thrown and fastened a roof of buffalo skin prepared as to resist the weather. The diameter of these lodges is usually 10 feet; some of them are larger. In cold and stormy weather the fire is lighted in the center of the lodge. In warm and fair weather the fire for cooking is lighted near the entrance on the outside. The floor of the lodge is covered with buffalo skins, skins forming an excellent carpet."[28]

The Western Hemisphere affords a good opportunity to show the position of the fireplace over an immense "ladder" of latitudes. Beginning with Alaska, the lamp, which corresponds with the house fire, is kept within the dwelling. In southern Alaska among the Indian tribes the fire is placed on the floor in the wooden houses, sometimes a box filled with earth being the receptacle. The Makah Indians of Washington put the fire on the floor in front of the bunks. The Patwin of the Sacramento Valley, California, and the Maidu and Klamath of northern California place the fire in the middle of the hut and provide a smoke hole. The Tulolome (Athapascan) on Rogue River, Oregon, live in square pits boarded up. The fireplace is on one side and the smoke escapes through a draught passage.[29] The Carrier (Athapascan stock) had a central house fire, a smoke hole, and ladder for exit and entrance, but no cowl as among the Haida. Stones were used for andirons.[30] Communal houses had as many fires as families.

The Plains Indians, as cited, placed the fire in the middle of the tipi or lodge. In northeast Canada the Montagnais also place the fire in the tipi. The above may be considered the northern method of fire placement in general, and shows temperature and other environmental influences. In the southwestern United States we find the Ute and Navaho open-air tribes placing the fire in a box of stone slabs. The Pueblos anciently kept the fire in a stone box in the middle of the room. Now the fireplace is in the corner, covered with a hood and having a chimney made up of pottery vessels with the bottoms knocked out. The ancient subterranean or pit houses uncovered at Luna, New Mexico, had the fireplace near the center of the circular pit, off center, it is thought, on account of the ladder by which exit and entrance was effected through a combination door and smoke hole. Farther south the Pima fireplace was placed under the ramada or branch bower in front of the hut. It was sometimes protected from the wind by a wing wall of mud extending about two-thirds of the way around the fire, and a wooden rack is placed over the fire to set cooking vessels on. In the fires in the windbreak houses of the Pima three stones are placed in the fire for a similar purpose. Attention will be called to these features in the discussion of the stove.

---

[28] Edwin Bryant. Rocky Mountain Adventures, 1848, p. 110.
[29] Bull. U. S. Geol. and Geog. Surv., vol. 10, p. 29.
[30] A. G. Morice. Trans. Canad. Inst., 1892–93, vol. 4, p. 187.

In Mexico, generally, the fire was placed outside the door of the house. In Colombia, at Panquita, in the mud huts the fire was placed in the middle of the room between three stones.

The Caribs of British Guiana had a fire outside the house. The Caribs of Dominica built their fire under the shedlike structure of their houses. The larger communal structures of northern South America southward, which consist generally of a roof on posts, had a house fire in the center or near the hammocks of their occupants. In the communal house at the junction of the Uapes and Rio Negro, Brazil, there was a fireplace to each family.[31] To the south in this vast continent (Chaco, Patagonia) the outside fire was common. The Fuegians in their most inhospitable region made little use of house fires, but the Yakgan Tribe built conical wigwams with the hearth in the center.[32] This sketch merely shows some of the environmental influences which governed the placing of the house fire. In the east and west extending Old World the picture becomes more complicated. In Europe the subject will have to be discussed under the stove warming and cooking devices as improvements on the home fire. Vestiges of earlier methods, however, have survived in less-advanced groups of peoples. In general, north Europe reflects in all its arts the lower winter temperature, and southern Europe the conditions which obtain in warmer climates and are similar to those of the Near East.

In Persia the fireplace is put in the middle of the room and consists of a deep, round hole in the floor, in which charcoal and cow dung are burned.[33] This form is used by the lower classes.

William de Rubruquis, on his visit to the Grand Khan at Mangou, Northern Tartary, in 1254, writes that in the center of the apartment

---

[31] Alfred Russell Wallace. Narrative of Travels on the Amazon and Rio Negro, London, 1853, pp. 275-277.

[32] Journ. Anthrop. Inst., London, 1886, vol. 15, p. 144.

[33] Woman's Work for Women, January, 1888, p. 11, and October, 1888, p. 259.

(the tents of the Grand Khan) was an open stove in which a fire of thorns and other dried sticks mingled with cow dung was burning.[34]

An interesting example of primitiveness is seen in the fireplace of of the Mongols of Lob Nor. "We enter one of these huts, the earthen floor of which is covered in places with old bits of felt, while in the center a cavity surrounded with flat stones serves as a fireplace. Here, as in other villages, we are seated in a circle round the hearth, the fire being made of bundles of dried reeds. The ends are lighted first, and the flame gradually consumes the stalks, a little girl pushing the bundle farther in as it burns. The flame is very vivid, so as we get a better light than we should from a lamp, and are as well warmed into the bargain, we have nothing to complain of."[35]

"The wood used for the flooring of Solomon Island dwellings is the hardest obtainable, and seems to be of a material which takes no heed of wear and tear. One log, tougher than the rest, is placed in position by the door, and on this a fire will probably be burning and a woman squatting by it cooking her lord and master's evening meal."[36]

Developments of architecture, principally enforced by the conditions in higher latitudes, the needs of more fire, and consequent smoke nuisance, demanded that the fire be placed on the side or in the corner of a room and provided with an outlet, from which arose the ventilated chimney.

Subsequent history of the fireplace has to do with the employment of fire for warming, cooking, etc., and treats of inventions as set forth later.

Among the Malays, Selangor, Malay Peninsula, "the commonest type of hearth is the Malay box hearth, which consists of a shallow box filled with earth, upon which are usually laid, in a triangle, the Malayan fire stones, between which a fire is kindled. Fire logs, such as are used by the inland Sakai, are, however, often to be seen."[37]

RUDIMENTS OF INVENTION IN THE FIREPLACE

In many places observers have noted the smaller arrangements in primitive fireplaces which usually escape mention. We see the fireplace as a shallow basin or pocket in the earth, more or less worn down by raking out the ashes and by fire action. It assumes naturally the appearance of a circular shallow place for the fire, located for convenience and safety. The placing of the fuel has much to do with the contour of the fireplace.

---

[34] Lives of Celebrated Travellers, vol. 1, p. 25. See also the Hakluyt Society's edition of Rubruquis.

[35] G.Bonvalot. Across Thibet, New York, 1892, pp. 77, 94.

[36] The Savage South Seas. Painted by Norman H. Hardy, described by E. Way Elkington. Published by A. and C. Black, London, 1907, p. 19.

[37] W. W. Skeat and C. O. Blagden. Pagan Races of the Malay Peninsula, 1906, vol. 1, p. 124.

There appears an invention to raise the fuel above the fire bed and promote combustion, consisting of stones set in the fire.

The fireplace of the Nascapi Indians of Labrador is in the center of the tent and is composed of several large stones to support the sticks of fuel laid across them.[38]

In the mud huts of the United States of Colombia the fire was built between three stones.[39]

Almost all of the primitive fireplaces had as an early addition perhaps a bordering circle of stones, which, among other things, facilitated the keeping of the fire and protected it in a measure from winds. At a later stage we see three stones or bosses of mud placed in the fire as a rest for the cooking pot. Trivet bosses of baked clay in one piece, forming a fireplace, have been uncovered in ruins of both the cliff and open-air type in New Mexico and Arizona by the writer (pl. 2, figs. 1, 2).

These primitive andirons are suggestive, and it is allowable to see in them the rude beginnings of the stove and an approach to the idea of draught. Three pot supports are seen in simple stoves in various localities (see p 48). The erection around the fire, consisting of four posts with cross sticks, used for drying, roasting, or smoking food, prefigure further additions of the stove. Morton, quoting from Josselyn and Young, describing the wigwams of the New England Indians, says: "One good post they set up in the middle that reaches to the hole in the top, with a staff across it. At a convenient height they knock in a pin upon which they hang their kettle. Beneath that they set up a broad stone for a back, which keepeth the post from burning."[40] The boxing in of the fire with circles of stones, slabs, or mud or daub and wattle walls are steps toward a better utilization of fire and hint at coming inventions. Occasionally a considerable advance is seen in ancient fireplaces. In the ancient pit houses at Luna, New Mexico, the writer uncovered a hearth in the side of a pit. The bottom was a smooth stone slab and the jambs were slabs of clay baked hard by the fire. The stone bottom projected in front, forming a little step.[41] The central fire in these pits was laid sometimes on a pavement of stones (pl. 2, bottom).

The rudimentary oven is observed in the primitive fireplace where food to be baked is buried in hot ashes.

The chimney might have its origin in the embankment, walling in, or other protection of the fire from wind. The idea of draught had not yet appeared. Sooner or later a simple knowledge of draught has

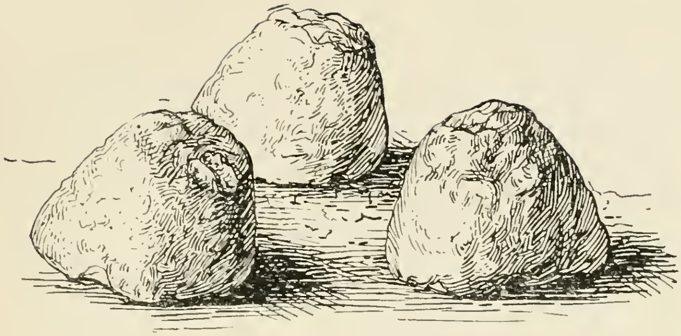
---

[38] Manuscript of Lucien M. Turner in United States National Museum, p. 454.

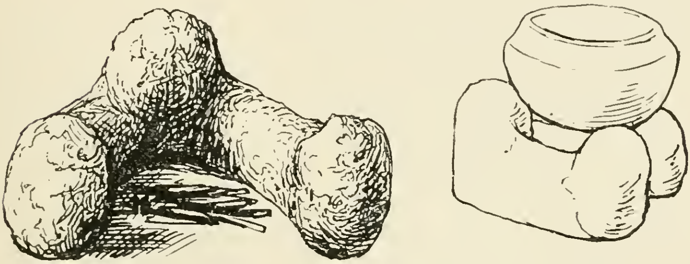
[39] Woman's Work for Women, November, 1887, p. 294.

[40] Josselyn's Voyages, p. 126; Young's Chronicles of the Pilgrims, p. 144; Note in Morton's New English Canaan, Prince Society, Boston, p. 135.

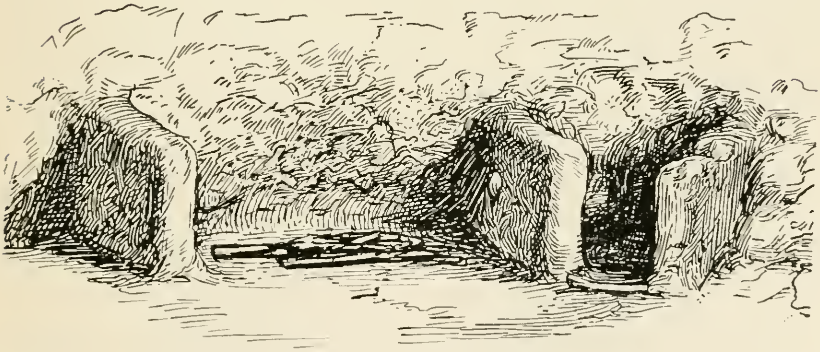
[41] Walter Hough. Ancient Pit Dwellings at Luna, New Mexico, vol. 55, Proc. U. S. Nat. Mus., 1919, pp. 409–421.



Stone Rests in Ancient Fireplace, New Mexico

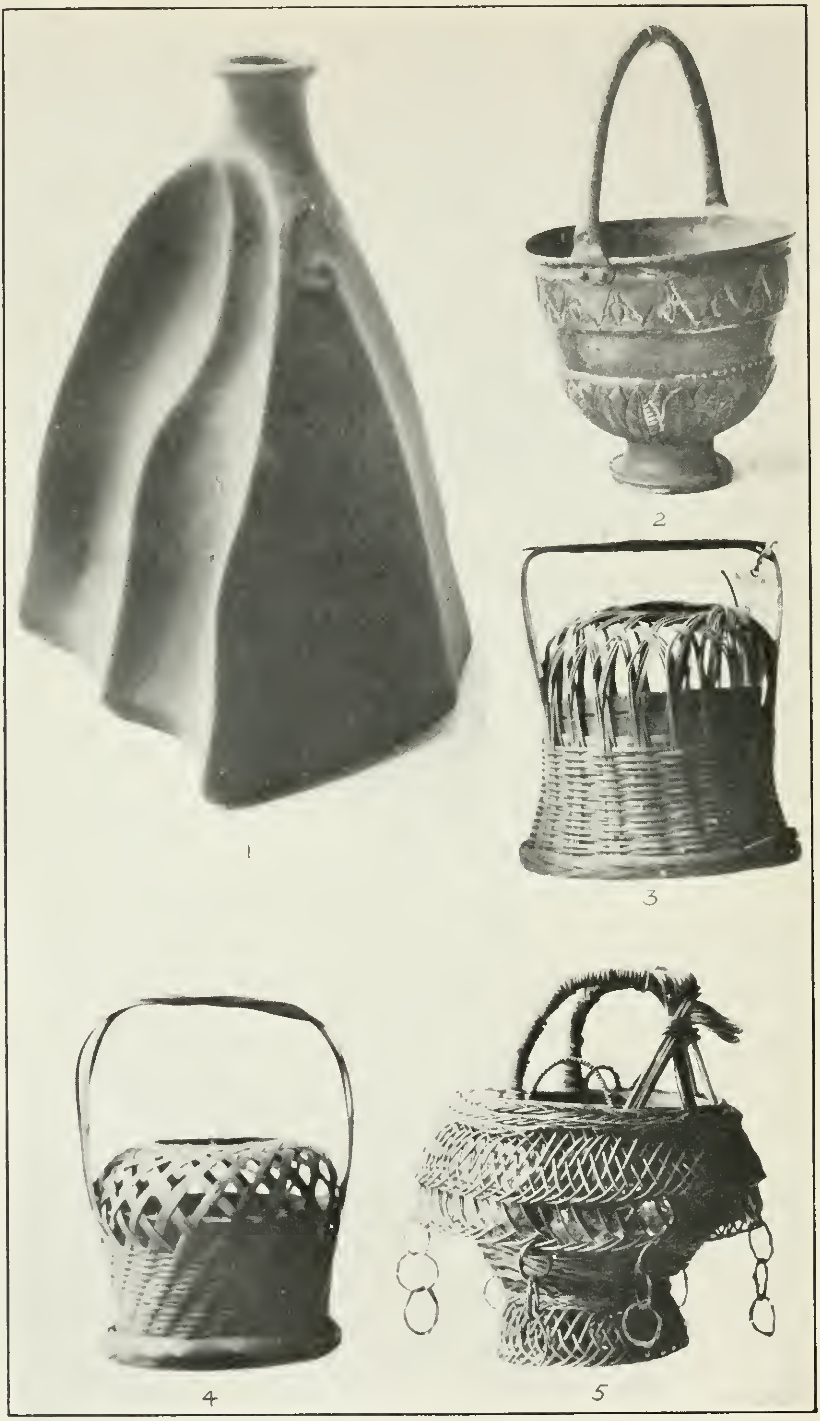


Trivet Bosses of Baked Clay and Method of Using



Ancient Pit-house Fireplace, New Mexico

For description of plate see page 12



1, Pottery Hot-water Bottle with Depressions for the Feet; 2, Italian Scaldino or Ambulant Stove; 3, 4, Chinese Hand Warmers; 5, Kachmerian Wicker Hand Stove

For description of plate see page 13

been gained, and perhaps direction of smoke is the first object sought. It is observed, however, that some natives appear to be apathetic toward smoke, and primitive appearing house fires among many tribes have little provision for carrying smoke away. In a sense the aboriginal house may be conceived as a protection to the fire and the structure itself a chimney. In pre-Columbian times there were no chimneys in the Western Hemisphere. The chimney was early introduced in America, principally from Spanish sources. There is a chimney of brick in Gloucester County, Virginia, which is reputed to have been Powhatan's; in any case it belongs to early colonial times, The Pueblo Indians, being practical housebuilders and willing to make improvements, adopted the chimney many years ago. In post-discovery America the use of the chimney was sporadic. The great mass of the population retained the time-honored open fire.

In Europe the chimney is not very old, having been introduced in the fourteenth century. The development of the chimney took place with other developments of the fire for special purposes and betterments, and will be discussed under cooking, warming, etc.

FIRE IN ARCHITECTURE

Fire has had an important influence in architecture. We may regard the primitive house as circular and conical, and built to contain one family. This type has the fireplace in the center and the apex of the roof is left open to carry away the smoke. It is distributed widely in the world among the less-advanced peoples. Ancient references, inscriptions, and other such data show the beehive shape house as probably the earliest form having definite architecture, an advance over the simple windbreaks and lean-tos. We have suggestions of the curved or softer type of structure design in nature. The primitive circular house and its fire must be in conformity, and the house is built around the fire for several reasons. The first reason is that the house is built of inflammable material, and the fire can not be safely laid to one side. Another reason is that the fire in the center allows the greatest area of floor space at an equal distance from the heat and light. Furthermore, the fire and smoke exit must coincide, and one of the earliest observations was that smoke goes upward and into the conical roof, which in this sense is a forerunner of a knowledge of draught, this conical roof exteriorly being the form to shed water. The house has been spoken of as "clothing for the family." It is suggested also that its earliest purpose was the housing of the fire.

The communal house is later, and evidently is the coalescence of several family units under a more highly developed social order. Here we have each family with its own fire. The style of architecture is changed to oblong, but the interior partitioning to separate the families becomes rectangular. A suggestion of the coalescence to form the long or communal house is seen in James Teit's description of the houses built by the Thompson River Indians on the occasion of a feast. These Indians built round lodges with fire in the center and smoke hole above. For the festival they built two lean-tos with fronts facing, and made fires along the alley between. They covered the alley with brush and poles thrown over the two sections, forming an immense lodge.[42] Another suggestion is the grouping of five huts among the Fuegians, with fire in center of the group.[43]

The theory offered, therefore, is that the relationship of house fire to the house in the open country, away from caves and natural shelters, is: Fire in front of a windbreak; in middle of circular break; in the middle of the conical house, supposed to be an archaic form; in the compartments of the communal house; in square or oblong rectangular houses, generally in the center, and with the development of architecture at the side or end of the room.

HEATING APPLIANCES FOR SPECIAL USES

At first the fire in the house was not for any special purpose, but was of general utility. The divarication of the fire had not been carried on to any important degree. The prime ideas of warmth, light, and heat for cooking covered most of the employments of fire, however, and were concentrated in one fireplace. The great advancement which grew out of the simple fireplace is characterized by the multiplication of devices through which portions of fire are made to do special work. These devices are innumerable, and are indices of the stages of progress through which man has passed. They mark a very substantial progress, on the whole without retrogression, slow in the earlier stages and in the later stages rushing to an enormous development not to be catalogued or comprehended.

If warming the habitation was incidental in the early uses of the fireplace it is because such need was not apparent. It is presumed that man was inured to stresses of lower temperature, which even in tropical latitudes seem grievous at times. It may be surmised that fire as a warming agent was appreciated by anaemic or enfeebled persons, or on certain occasions, as childbirth. Nevertheless, warming is established from the first as one of the important ideas to be developed in overcoming environmental conditions.

"And the servants and officers stood there who had made a fire of coals, for it was cold; and they warmed themselves; and Peter stood with them, and warmed himself." John xviii, 18.

---

[42] James Teit. The Thompson Indians of British Columbia, Mem. Amer. Mus. Nat. Hist., New York, vol. 2, Anthrop., p. 1, April, 1900, p. 196.

[43] Fannie B. Ward. Evening Star, Washington, Jan. 16, 1892.

The application of fire to bodily wants, expressed in warming the body or parts of the body and the house, falls into the classes individual, family, and collective, as follows:

HEATING

Application of fire to bodily wants

- Warming the body and house
  - Individual
    - Hand stove, foot stove, pocket stove.
    - Fire pot.
  - Family
    - Family fire.
    - Brazier, stove lamp.
    - Fireplace.
  - Collective
    - Hot-air furnaces
      - Water.
      - Steam.
      - Gas.
      - Electricity.

As a preliminary remark, the use of fire extemporaneously for warming presents many instances regarded as unusual and not falling in line with established customs or presenting features of development from anterior sources. One of these curiosities in the use of fire was told the writer in 1900 by Dr. Edward Palmer, who said that the Cocopa Indians on the road in winter build a fire on the sand for the purpose of heating it. When the sand is heated they dig a hole beneath the place where the first was set, crawl in the hole and, drawing back the warm sand over themselves, sleep comfortably during the night.

Another instance, somewhat less ingenious, is given by Rockhill: "We passed several Mongol shepherds carrying about on the end of a stick a smouldering bit of dry dung. Now and then they used it to light a bunch of grass and warm themselves by the blaze."[44]

In the line of development the fireplace comes before the usages in which small portions of fire were inclosed in various ways for special purposes. This specialization of uses of fire has grown enormously from small beginnings, and furnishes an interesting group of objects reflecting various periods and customs.

Standing first in simplicity in applying heat to the body or parts of the body are the methods taking advantage of the retention of heat by various substances. One of the curiosities of the Tradescant Museum, an institution founded in the seventeenth century and progenitor of the Ashmolean Museum at Oxford, was "a brazen ball to warme ye nunnes hands," as the old catalogue quaintly phrases it. If this brazen ball was solid metal and not a hot-water container it is in advance of the often extemporaneous stones, hot bricks, and flat irons, which no doubt have had long use and which probably will never be superseded. Spherical balls of metal with screw caps, late sixteenth century English, used as hand warmers, are examples of hot-water containers, as are the basins ornamented with heads dug up at Chester and dating from the Roman period in Britain.[45]

---

[44] W. W. Rockhill. Journey Through Mongolia and Tibet, Smithsonian Institution, Washington, 1894, p. 35.

Many varieties of the hot-water containers have been developed. As novelties in the English potters' exhibition at the Philadelphia Centennial in 1876 were foot-shaped vessels for hot water intended for placing in boots for drying them, and concavo-convex vessels for applying heat to the abdominal region. The Museum has a rare pottery hot-water bottle (pl. 3, fig. 1) with formed depressions for the feet of a lady. This vessel is of glazed Binghamton earthenware and dates about 1840. Several varieties of hand stoves are found in eastern Asia. They are usually of brass or copper, and consist of a small rectangular box with perforated lid like an incense burner, and have a handle. They are often quite artistic pieces of workmanship (pl. 4, fig. 1). Sven Hedin found this variety of heating device at Lan Chow, western China, and says: "Among other things I bought *sha-los*, or hand stoves, shaped like teapots but with grated lids. You fill them with ashes, and put two or three pieces of red-hot charcoal in the middle of the ashes. The *sha-lo* will then keep warm for a good 24 hours."[46]

The Japanese pocket stove, or belly stove, as it is called, is much in advance of the examples previously described in that it employs a specially prepared fuel whose origin is probably in ancient experiments to produce a slow match for preserving fire for a long time. The pocket stove is a box of copper or tin slightly curved to fit the wearer, and with perforated sliding lid. Paper cartridges filled with powdered charcoal of a specified kind are placed in the box, lighted at one end, and the lid closed. One charge gives out a gentle heat for four hours. Such stoves are cheap, useful, and efficient. Another form widely spread is a small vessel with handle, in which a charcoal fire is carried about and used to warm the feet and hands. Perhaps the more familiar example of this personal stove is the *scaldino* of Italy, possibly of quite ancient origin (pl. 3, fig. 2). These little stoves are made of bronze and terra cotta, vase shape, with lid. Sometimes they are real works of art, designed for use by the elite. In China such stoves consist of a pottery bowl neatly incased in bamboo basketry. The Chinese bamboo portable stove has a base of sufficient diameter to prevent tipping over and is carried by a handle. (pl. 3, figs. 3, 4). A similiar vessel, called Kangri, is used during cold weather at Srinagar, Kashmir. The fire bowl is incased in elaborately woven osier over plates of mica. On top is a yoke-shape frame with a loop for carrying without getting the fingers burnt. Collected by Dr. W. L. Abbott (pl. 3, fig. 5).

---

[45] L. M. Solon. The Art of the Old English Potter, Derby, 1885, p. 16.

[46] Sven Hedin. Through Asia, vol. 2, 1889, p. 1205.

Among the numerous artistic forms of footwarmers is the Italian copper bucket with brass lugs and bail covered with arabesque designs. The lid is coronet shape, the base of brass rods forming a foot rest and preventing the clothes coming in contact with the coals.

In the Biblia Pauporum of 1410[47] is pictured an oblong box rectangular in shape, with strap bars around the sides containing fuel. This fire basket, which is intended for warming the feet and hands, is a movable grate which probably antedates the brazier, as in it could be burned wood. It suggests in shape the ordinary French chauferette or foot warmer, a rectangular box with perforated lid and a handle. A French foot warmer of the eighteenth century in the National Museum is oval in shape of fine brass well wrought. The lid is surmounted with a grid of brass strips riveted on. The lid is ornamentally perforated with diamond pattern and is hinged. The bail has a handle of wood.

A Flemish example dated 1785 is a quaintly formed bucket of brass with a heavy bail hooked into lugs. The lid is convex and is perforated in heart and spearhead design. A beautifully perforated Flemish brass foot warmer is shown in Figure 2, Plate 4. A curious Flemish foot warmer utilizes the hot plate instead of the direct heat of charcoal. The lid is a plate of cast iron overlaid on the upper side with brass. The lid fits on a perforated brass drum having an ornamental foot. The bail is of heavy brass rod. The heating appliance is lost, but was evidently a shallow pan for the coals. It is probable, also, that the smooth flat top of this stove had some craft or domestic uses.

The foot stoves of the United States going back to colonial times are all of the same type, consisting of a wooden frame inclosing a perforated sheet-iron box having a hinged door. Usually there are four turned corner posts holding together the top and bottom of the frame. The ornamental perforations are interesting examples of folk art. Such stoves were principally for carrying to the unheated churches of early days. A similar English foot stove is an oblong rectangular box lined with sheet iron and having a slat lid lined with perforated tin, and four vent holes on the sides lined with brass to aid ventilation. The bail has a turned wood grip (pl. 4, fig. 3). The foot warmers of the United States seem to be of English derivation.

The demand for foot stoves in America influenced one of the early examples of manufacture in quantity. The location of this manufactory is not known to the writer, but finding so many duplicates is good evidence to substantiate the statement.

---

[47] J. Ph. Berjean. London, 1849.

Foot warmers reflect the drawbacks of the architecture of past time, when provisions were not made for heating and ventilating public buildings, as churches. The foot stoves of New England recall this period, when such primitive devices were carried to church to prevent discomfort or even freezing in the cold assembly hall.

LAYING THE FIRE

There is not much information available for the general treatment of this subject. It appears probable, however, that some order in placing fuel on the fire was early worked out as the result of endless experiences in the past. Such matters were unobserved as of no consequence, and what appeared to be normal may have been the result of designed actions known to be best for the purpose. For this reason only unusual or striking methods were recorded.

Economics of labor and fuel and a method of laying up and preserving fire is observed among the Creek and other southern Indians. Four logs are cut and laid at right angles, the ends abutting and being thrust in as they burnt away. At the junction fire is built. The Cherokee, however, pushed the sticks in parallel, burning them from one end.[48] The Jivaro Indians of Ecuador use three logs similarly and where a larger fire is needed throw small wood on the junction and fan to a blaze with a fan of plaited grass.[49] Among the southern Indians the cross-shaped fire took on a religious significance, and was prescribed at ceremonies such as the Busk or Green Corn Dance.

Among the Mandans fire was built with two sticks crossed in the center, which were pushed in as they burnt. "This was done because the First Man told them they must never have a big fire after the day's cooking, and showed them how it should be built. It recalls the sacred fire of the Muskogi and other tribes of the lower Mississippi."[50] A cruder method was employed by some eastern Indian tribes. A sizable tree convenient for handling was dragged up and one end thrust through the side of the hut to the fireplace. When the wasting away of the burning end rendered it necessary the log was thrust forward.[51]

The methodical laying of the fire logs in the great fireplaces of northern Europe, transplanted to American, may have had such a nomenclature as was expressed in Virginia in 1840. There were four elements, backlog, top log, fore stick, and middle stick, showing an order which is suspected of having ancient descent. This arrangement made a perfect fire, smaller logs being added against the substantial backlog as required.

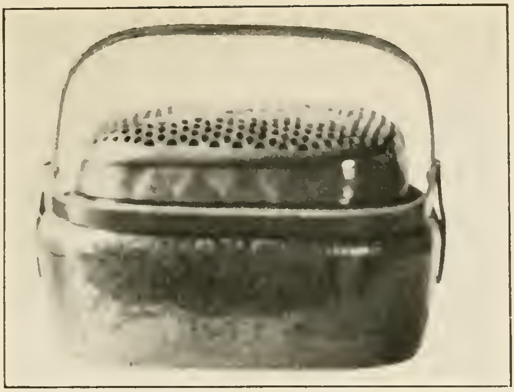
---

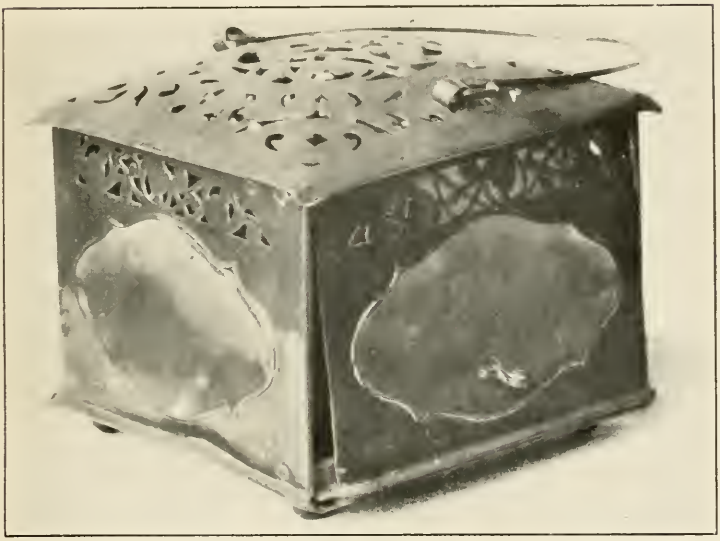
[48] R. B. Marcy. Reconnoissances in New Mexico and Texas, 1850, p. 219.

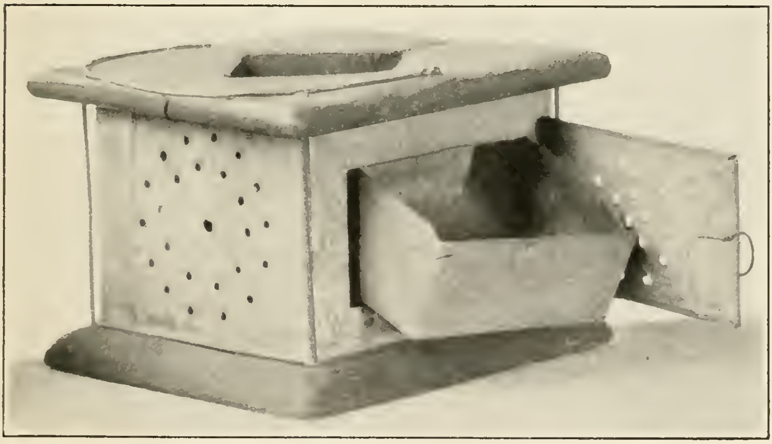
[49] A. Simson. Notes on the Jivaros and Cabelos Indians, Journ. Anth. Inst., 1880, May, p. 286.

[50] Will and Spinden. The Mandans, Pap. Peabody Mus., vol. 3, No. 4, Cambridge, Mass., August, 1906, pp. 134–135.

[51] Thomas Morton. New England Canaan, Prince Soc., Boston, 1883, pp. 134–136.



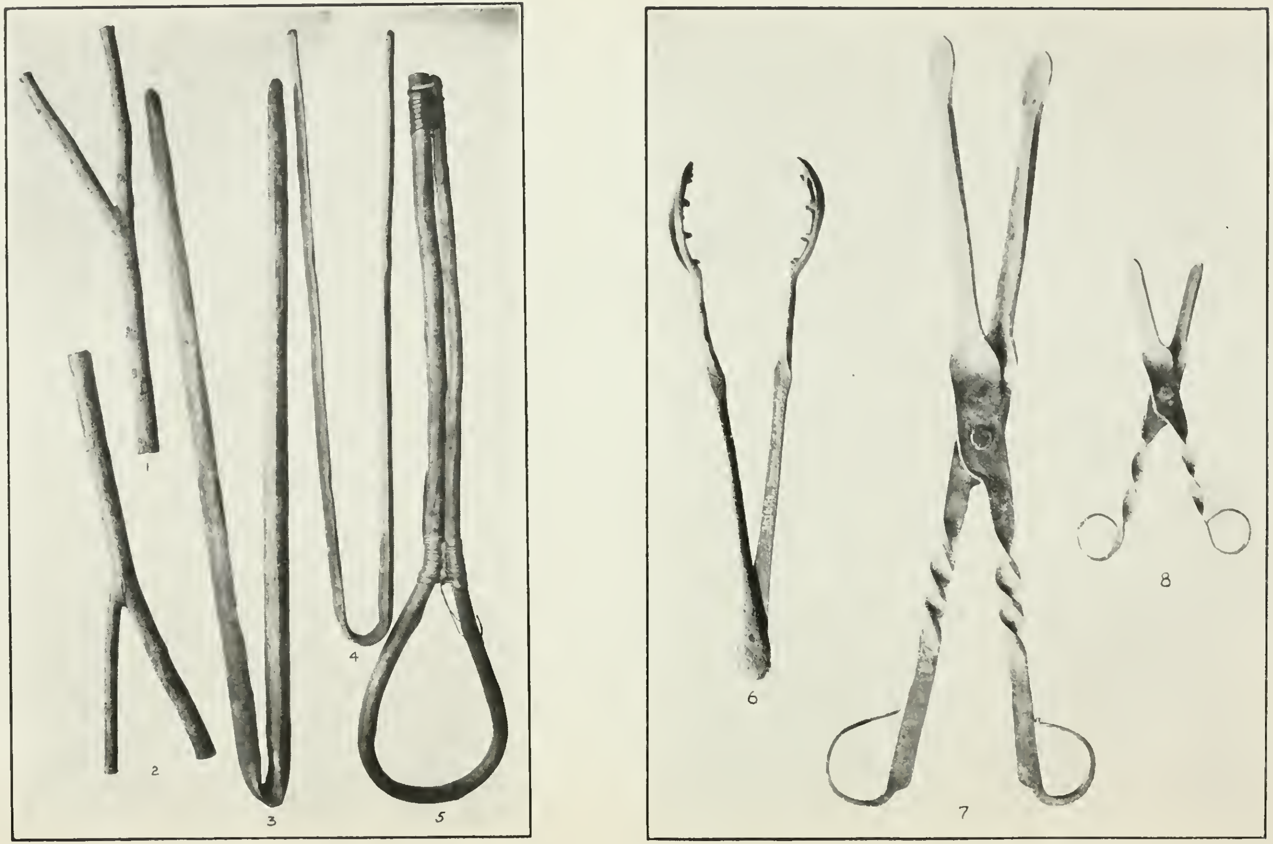




HAND WARMERS AND FOOT WARMERS

Toy, Western China; middle, Flemish; and bottom, United States

FOR DESCRIPTION OF PLATE SEE PAGE 17



American Indian Tongs

1, 2, Pair of Kiowa crotch stick tongs; 3, Apache, Arizona; 4, Havasupai, Arizona; 5, Washoes, Nevada; 6, Fire-borrowing tongs, Denmark; 7, 8, Spanish pincer tongs

For description of plate see page 19

DEVELOPMENT OF FIRE TOOLS AND FURNISHINGS OF THE FIREPLACE

In extension of the remarks covering the rudiments of invention in the fireplace, the growth of these inventions may be followed to the threshold of the age of progress.

It is evident that the first fire tools were sticks, ancestor of the poker. Such undifferentiated pokers are always present around the fires of unadvanced peoples. Necessarily the poker is not subject to differentiation, and remains throughout the ages a straight tool for stirring the fire.

For removal of a brand or heated stones from the fire tongs have been invented. The simplest form would be two sticks held in the hands in apposition against the object to be removed (pl. 5, figs. 1, 2). Among the Northwest Coast tribes two sticks with a grommet of bark or twisted wand over one end suggest tongs. The sticks are flattened on one side and form an efficient tool. Less useful tongs are made by splitting a stick part way. The Pueblos and other Southwestern tribes work out a stick into two spring prongs and use them for picking up spiney fruit of the cactus and coals (pl. 5, figs. 3, 4).

In a cave in Utah, Palmer found ancient wooden tongs. The same style of implement is now used for handling hot stones, either to place them in boiling food or in the roasting trays for preparing seeds.[52] Following these is a long line of tongs showing minor variations which reaches to the present.

Scissorlike tongs are found in Spain for use about the brazier (pl. 5, figs. 7, 8). The small bronze tongs shown are Danish and were used in borrowing fire (pl. 5, fig. 6).

In the development of the fire shovel the crotch stick used for lifting is presumably a very early form. The Pomo and other California tribes made a lifter by bending a slender rod of wood at the middle portion into a loop and the straight parts of the rod are brought together to form a handle. When finished this implement is like the eastern Indian ball racket without the net lacing (pl. 5, fig. 5). Generally in America such devices are used where boiling by means of hot stones prevails and for moving the stones for the sweat bath. The fork and the shovel appear to be one in development. A very ancient two-tined fork of copper found by Schliemann in Mycenae was identified by him as an implement for stirring and regulating funerary fire.[53]

The fire-blowing tube has survived in Europe. A specimen secured in Spain in 1892 by the writer consists of a brass tube, the upper end open full and the lower end having only a small hole, the object being to send out a jet of air under pressure. The lower end has two iron prongs for stirring the fire and the upper end a curved hook for hanging the implement to a suitable peg. The two prongs on the end of the Spanish fire blower also suggest a survival.

---

[52] First Ann. Rept., Peabody Museum, 1878, p. 270.

[53] Henry Schliemann. Mycenae, London, 1878, p. 255.

Early shovels consist of a thin, circular, flat disk at the end of a handle. The cult shovel of the Parsee used to tend the sacred fire and the Spanish shovel for tending the brazier are of this form (see pl. 8, fig. 2).

The curved shovel is of comparatively recent invention, while the flat shovel reaches back to the Bronze Age.

ANDIRON

The andiron, as noted in another place, has its first steps in the primitive arrangement of the fireplace, namely, the three or four stones put in the fire to support the wood, and much later to support cooking vessels. The primitive stone andirons are perpetuated in the three bosses of simple stoves of warm countries, and presumably of tripod vessels under which fire was built. The long metal andirons are perhaps related to the four stones placed in the fire or to the slabs placed at the sides of the fire. They may refer also to the grate bars.

The study of andirons, with various additions growing out of the needs of the different periods through which this primitive device has passed, would begin and parallel the history of the stove. From the stones in the primitive fire to the elaborate landiers and andirons of the French there were many additions applied at the demands of the cook, until at the later stage the andiron becomes both a support and a stove.

TRIVET

The trivet is an iron stand with three feet, used for raising vessels above the fire and in this sense a special andiron. It is an introduction of the Iron Age, and morphologically would be represented in earlier stages by the three stone supports set in the fire.

GRIDIRON

The name refers to the Iron Age, but the form in wood is doubtless far more ancient, and from which the gridiron may have been derived. These structures of wooden rods laid upon crosspieces supported by forked sticks were not designed to resist fire action, but were for preserving food by semicooking, smoke, and drying. Examples are found among native tribes everywhere. The device need not be considered as acquired, but is likely to be independently invented through necessity. Historically the first description of this gridiron in America was by John Smith concerning the Virginia Indians, and giving a drawing by John White, about 1600.

The iron gridiron of ancient antecedents was a most valued utensil and was employed so long as the open fireplace survived. Examples are now preserved in museums, where they are interesting especially for the skill displayed in their artistic ironwork. The gridiron being an essentially indispensable device in cooking, has taken its place in the elaborated cooking stoves and has its latest use in the electric toaster.

GRATE

There is little information available on the antiquity of the grate. The grate as such, with bars, does not appear till quite late, with the stationary fireplace. It is necessary to look for its earlier forms in the heating appliances where draught is utilized. Here it occurs in the bars to prevent the fire falling below into the draught chamber of braziers and simple stoves. A suggestion of the grate is seen in the gridirons which appear in the Iron Age. In the necropolis of La Quenique, Court-Saint-Etienne, Belgium, of the Hallstadt period, early Iron Age, were found "a curious group of household utensils, all of iron, composed of the following pieces: A large fork with a *douille*, dowell, a kind of fire shovel with hollow rod, and part of a grate made of a single piece of bifurcated iron bent many times. A similar grate, but complete, was found in 1909 in the course of the excavations of Alise. It measures 1 foot 5 inches long and about 7 inches in width. It was accompanied by a fire shovel similar to that of La Quenique."[54]

CRANE

The necessity for suspending vessels over the fire is expressed in various inventions, the simplest of which appear to be rod spits and the gridiron grate. The rod spits, holding meat to be roasted, stuck in the ground and inclined over the fire, precede the crane. The iron rod of the Gypsy, which is used as the wooden spit, is a curious survival which serves now for suspending the cooking pot. The tripod, which is attributed to the Gypsy, appears not to be a characteristic device of this people. Another form suggesting the crane consists of a wooden rod laid in two crotch sticks set in the ground at the sides of the fire. The needs of any period are met in much the same way. When the fire is placed in a built-in structure and the fireplace properly so-called has been developed, the need for the crane is present. It is a horizontal iron bar with a brace more or less elaborated by the blacksmith's skill, swinging on two pins anchored in the wall of the fireplace. This crane, common in the early part of the nineteenth century and probably going back into the Iron Age, has now become an antique. With the crane came an assortment of pothooks and occasionally folk invention produced an extensible ratchet or plug and hole pothook.

---

[54] Records of the Past, vol. 11, September-October, 1912, pt. 5, p. 123.

DEVELOPMENT OF DRAUGHT

Draught is of primary importance in the adaptation of fire to human needs. In all phases of the fire art some attention has been given to the air supply in combustion, and the plans for control vary from the most primitive to the exact calculated formulas and appliances of the present. The history of the valuable utilizations of methods to increase heat, so important to human progress, is first and chiefly concerned with draught and second with fuel.

The coals of a simple camp or house fire can be given temporary draught with a fan or such means. When a fire has a sufficient amount of fuel the uprush of heated gas and air currents gives the blaze observed and the necessary draught.

In a confined fire with charcoal as fuel there is a slow combustion without draught, and any extra heat required may be given by freshening the coals with a fan or blowing tube. With natural wood fuel, however, there is required aeration from below in most cases to insure combustion without too much smoke.

Draught is classified as:

1. Natural, in the uncovered fire caused by uprush of heated gas drawing in below displaced air; without design.

2. Induced, by placement of stones around the fire and a stone or vessels above the fire; by raising the fire above the base level; and regularly piling the fuel. The first steps of designed draught are seen here.

3. By piercing holes above the fire and a confined vessel; by piercing holes in the bottom of a vessel; by base or under structure giving an air chamber. Later these features are combined in one stove.

In the simple fire receptacles where small portions of heated fuel are installed, there is no provision for draught. It appears that for a long period no necessity for draught arose aside from simple blowing or fanning, as mentioned under bellows, which would be sufficient to brighten the fire for temporary uses. It is found that in the simple fire containers fuel was the important thing, and there is shown to have been a development of fuel leading to the use of charcoal. Charcoal marks a great advance, equivalent at least to an epoch-making discovery. Incidentally the extension of the use of charcoal, giving rise to a demand for this fuel, was responsible for the first inroads on the forests.

The minor fire vessels mark the first tentative elevating of fire above its primitive base line and paved the way for the application of draught beneath the fire. When charcoal is used as suggested, the necessity for aeration of the fire from below is not pressing, but in the burning of other substances for special purposes it was seen that draught was necessary. Beginnings are observed in burners for incense, where a few holes pierce the sides of the primitive pottery censers. It was customary to put in the vessels coals and throw upon them the incense. In many cases the gums used have a tendency to smother the coals, and this exigency was met by air holes to keep the coals alive. The rudest censers in America, employed by the Lacandone Indians of Mexico, figured by Dr. Alfred M. Tozzer, had no provision for draught.[55]

A slight draught was induced in many of the simple fire basins, especially those with projections on the rim, when a vessel was set on the projecting supports. There would be a slight current of heated gases and returning air through the openings caused by the holding of the vessel away from the wall of the stove by the projections. This draught evidently would not be sufficient to cause the installation of vessel and stove to be of more than limited utility, and side draught holes and under draught would follow.

In a censer from Carmen, on the coast of Honduras, of the goblet type, with mask on the edge of the rim, there is a small hole in the center of the bottom and two holes on opposed sides of the bowl. These orifices are small and they would appear to be of limited value in furnishing draught, but that is evidently the design. The small pottery fire pots of the Tule Indians of the San Blas coast, Panama, have a number of draught holes in the bottom. These are figured in the chapter on stoves.

The circular underground rooms called kivas, used by the ancient Pueblo tribes for ceremonial purposes, required some method of ventilation.[56] The fire built in the fireplace on the floor of the kiva and the presence of numbers of celebrants would vitiate the air to a dangerous degree at times. As pointed out, the tipi or lodge has a smoke hole at the apex and a door in the side, thus functioning as a stove. The circular kiva of the ancient peoples of the northern part of the Pueblo region had a flue running under the floor from near the fireplace to the wall, where it connected with an upright flue on the exterior (Bonito and other Chaco Canyon ruins); or the outside flue opened into the kiva at the floor level (San Juan region). Another feature of this installation is a deflector or screen of stone, wattle, or adobe in front of the fire, whose function appears to be the diversion of the draught. In the history of ventilation this feature of the ancient circular kivas may be considered a great advance. Such kivas have been uncovered in prehistoric sites and they show the use of draught ventilation in America at an indefinite time before 1540. Modern kivas have no such device, and for this reason it must be concluded that the knowledge of the ventilating flue passed out with the people of the circular underground kivas. As a suggested corollary, the people mentioned left no inheritance in the present Pueblos; that is, the stem was broken off.

---

[55] Alfred M. Tozzer. A Comparative Study of the Maya and Lacandones, Arch. Inst. Amer., New York, 1907.

[56] J. Walter Fewkes. Ventilators in Ceremonial Rooms, Amer. Anthrop., new ser., July—September, 1908, pp. 387—398.

In passing it may be said that the Hopi field-oven flue has no connection with the circular kiva ventilator.

BELLOWS

A very early experience coming to all who attended the fire was the effect of currents of air on combustion. Draught also determined the location and protection of fire to a great degree. These primitive dispositions were weighted with future advances of great importance. The encouragement of fire by means of currents of air has its simplest material expressions in a leaf which becomes the fire fan of world-wide distribution (pl. 6, figs. 1–6). This simple device does not arrive at its full development till in the highest civilization the fan blower is invented.

The impulse of human breath is an early method of blowing the fire and does not become tangible until the tube blower for concentrating the air appears. This device is met with in many parts of the world, and in America especially is connected with primitive metallurgy. The tube, it may be said, remains in the higher fire art as the tuyere of the furnace through which the blast is driven.

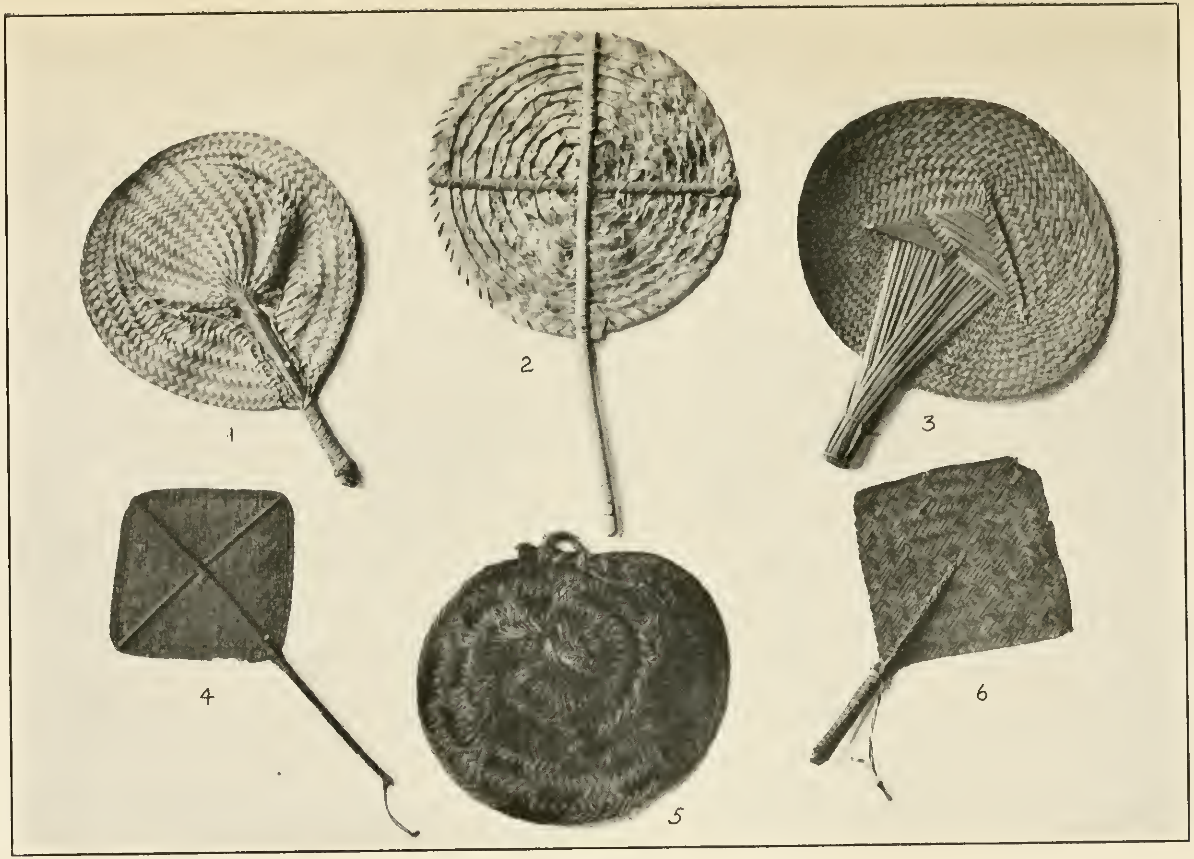
Much later than these devices comes the bellows in its simplest form, a bag for impounding the air and acting as the human lungs. Simple forms like this, consisting of a single bag furnishing an intermittent blast, are found in Asia (Tibet)[57] and Africa (Khartoum, Egypt, etc.). In Africa an advance is made by attaching two impounding bags to the nozzle. This device was known in Egypt as early as Thotmes III, as shown by wall decorations depicting two leather bags fitted in a frame, the operator standing opening the bags with a cord and closing the mouth alternately with his foot.[58] The Hindu bellows is also worked by the heel or thumb of the operator closing or opening the inlet.

The necessity of a continuous blast more easily manageable must have been obvious to the workers having the simple bellows. The first steps toward the valve are observed in Africa, where the structure of the bellows is a carved wood frame of Y shape with two bowl-shaped cavities at the ends of the arms. Over the bowls are tied somewhat loosely pieces of skin with the fur side inward. Plunging rods are fastened to the apex of the skin bags. On the upstroke the air is drawn in around the edges of the skin, and on the down stroke the fur is compressed against the edge of the bowl, giving a

---

[57] W. W. Rockhill. Journey Through Mongolia and Tibet, Smithsonian Institution, Washington, 1894.

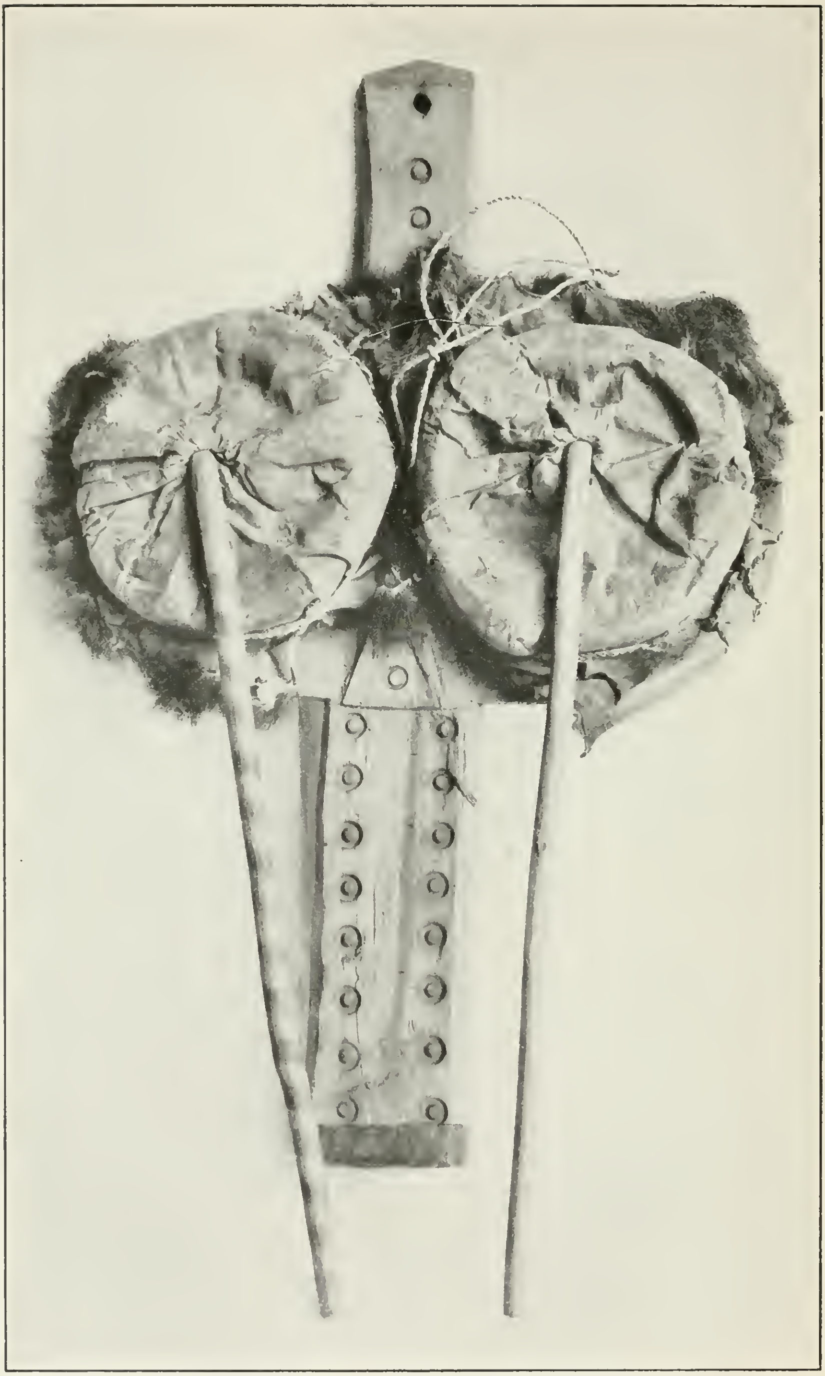
[58] J. G. Wilkinson. Ancient Egypt, New York, 1879, vol. 2, p. 312.



FIRE FANS

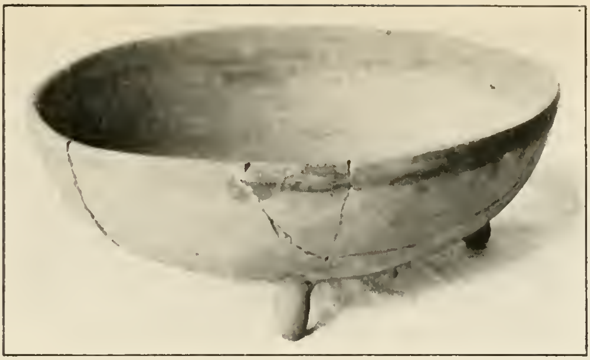
1, Paraguay; 2, Merida, Mexico; 3, Yucatan; 4, Cape Blanco, Morocco; 5, Spain; 6, Ecuador

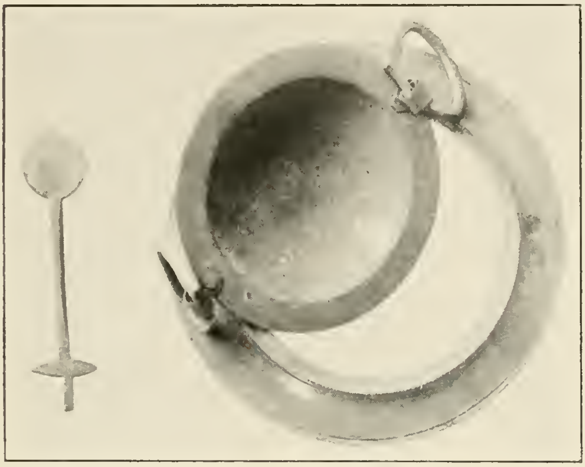
FOR DESCRIPTION OF PLATE SEE PAGE 24

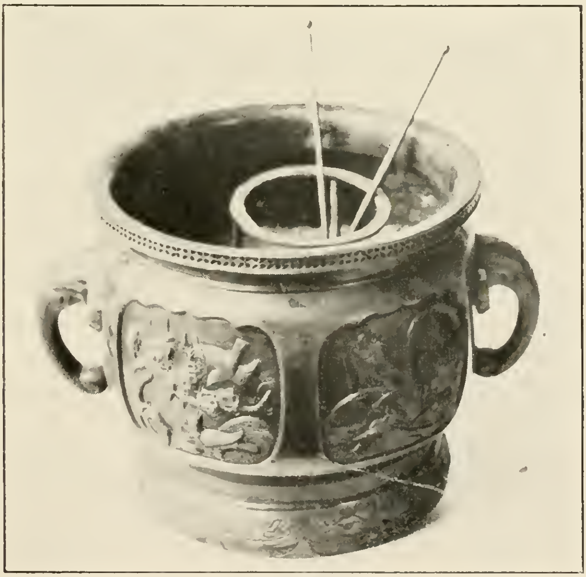


Primitive Valve Bellows. Gaboon, Africa

For description of plate see page 25



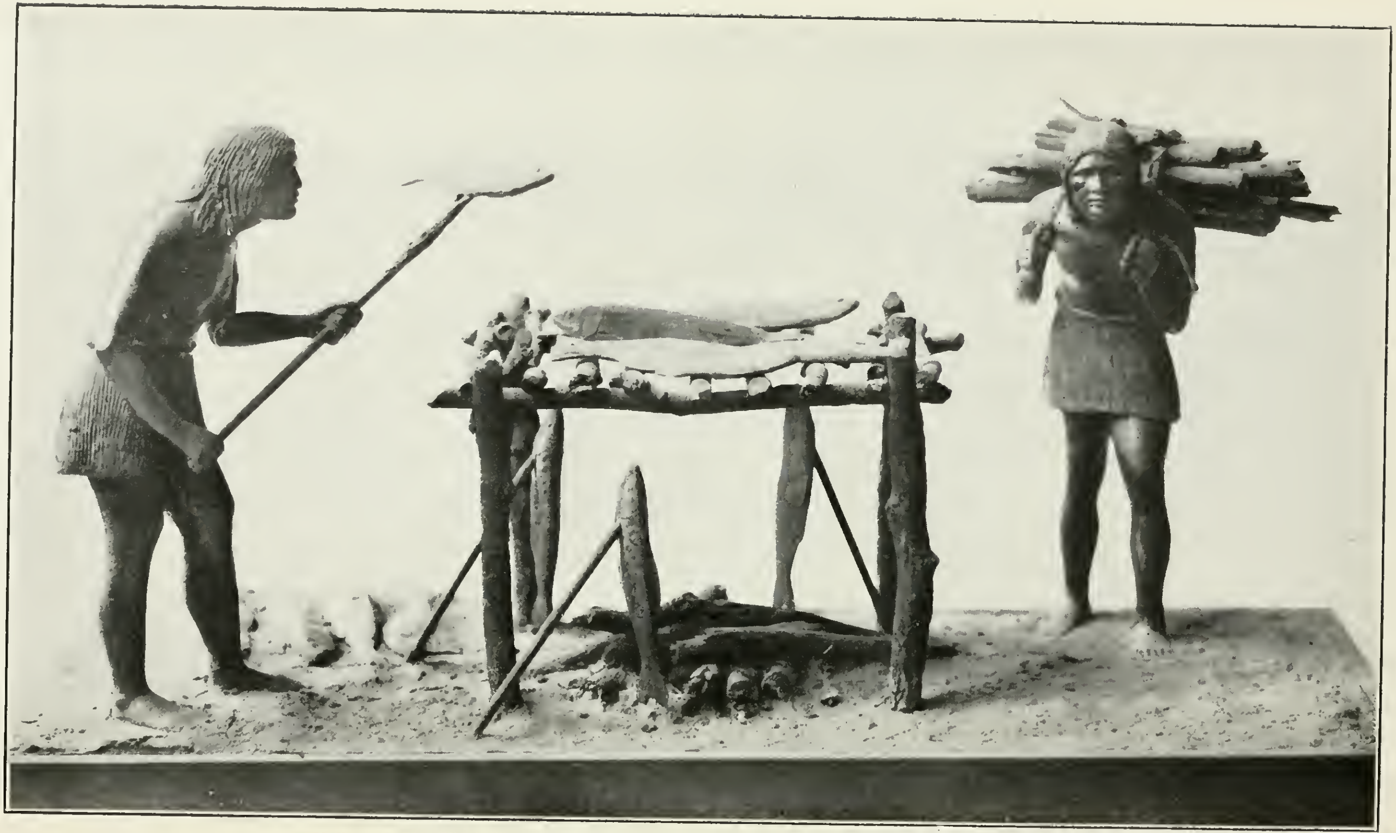




BRAZIERS

Top, Durango, Mexico; middle, Spain; and bottom, China. This massive bronze brazier was used by candidates undergoing the official examinations at Peking

FOR DESCRIPTION OF PLATE SEE PAGE 26



SPITS AND GRID OF THE POWHATAN INDIANS, VIRGINIA

From model

FOR DESCRIPTION OF PLATE SEE PAGE 33

valve action. This may be considered a most ingenious adaptation of means to an end[59] (pl. 7).

H. Mitford Barber describes the bellows of the Shangaris and Basutos in eastern South Africa. The bags are made from the whole skin of the sable antelope, with the orifice stitched up. The tubes are of the horns of the antelope cut off below the natural cavity and the base fastened into the bag. The other ends are thrust into two perforated stones laid against the fire. The valve is a slit in the center of the bag edged with two sticks having a loop for the fingers. The air is simply impounded and forced out, like bellows in southern India.[60]

A somewhat similar valve to the Gaboon specimen described is found in the piston bellows of Borneo, where two plungers tipped with a mass of downy feathers are thrust alternately into bamboo cylinders. The feathers act as a valve, as shown in the hair check of Africa. This type of bellows from its wide distribution, mainly in the Malay area, is called the Malayan bellows. The distribution is Siam, Assam, Salwin, Sumatra, Java, Timor, Philippines, Madagascar, and Dorey, New Guinea.

The Chinese bellows is a rectangular box with piston covered with cloth pulled by a rod with handle. The thick baseboard of the box has a slit at either end leading to a hole in the edge where the two openings meet. The ends of the air chamber are pierced with a small grating. There is no valve cover over the gratings in the specimen observed in the collections of the United States National Museum, and the inference is that they were stopped alternately by hand. Thus the bellows required two persons to work it and is in the valveless class. The Chinese, however, must be credited with knowledge of the valve.

The Japanese bellows is described by Perry: "Their bellows are peculiar, being a wooden box with air chambers, containing valves and a piston which is worked horizontally at one end like a hand pump, while the compressed air issues from two outlets at the sides."[61] The outlets are near the ends and are apparently closed with valves which act alternately on the back and forward stroke of the piston. This bellows is decidely in advance of the Chinese form.

The piston and box bellows were not introduced into Europe. The inheritance of the bellows was evidently from Africa in the form of the windbag, from which were derived all the various common forms with valves developed before the age of great invention.

In connection with this subject mention is made of a unique blast apparatus used by the Lepcha jewelers of Sikkim, India. It is of copper in the shape of a gourd with curved neck. At the end of the neck is a small orifice. The pot is heated, expelling the air within, plunged in water, and the vacuum created draws water within the vessel. On reheating, the steam issues violently from the spout and is directed on the charcoal fire in which is set the crucible, producing a heat sufficient to melt gold. This principle has been utilized in modern mechanics and is known as the steam-jet blast.

---

[59] Specimen from the Gaboon, Africa, in the United States National Museum. (Crt. No. 164,873, A. O Goode.)

[60] Journ. Anth. Inst. Great Britain, 1891, vol. 21, pp. 302–304, pl. 22.

[61] Japan Expedition Narrative, Washington, 1856, pp. 456–457.

BRAZIERS

Braziers are basin-shaped portable vessels, generally of metal, in which charcoal is burnt without draught to produce a small amount of heat for warming the extremities. They are extensively distributed, but are used mostly in countries of the southern temperate and tropical zone. They represent the installation of fire in a portable vessel and may, on account of the primitive aspect of the device, stand for the first taking of fire from its original base level on the hearth. The brazier, *foculus*, was used in Pompeian baths and was a box with four feet.[62]

The brazier or brazierlike appliances also had uses for cooking, and will be discussed under stoves. For these uses the fuel is not required to be charcoal.

Walpole's description of the Chilean brazier will apply to this device in almost any part of its range:

"The *brasero* is a circular pan of brass or silver which fits into a broad wooden frame (pl. 8, fig. 2). Over the *brasero* is sometimes placed a large basket, so that on entering a room nothing is seen of it till the lady draws back from what she and her gown had completely enveloped."[63]

Another writer says of the Spanish brazier: "But I found at Burgos the snow a foot deep in the streets, and a total absence of fireplaces. The Spanish brazier—a big brass warming pan wanting a handle but set in a wooden stool a foot from the floor—a fine thing for a chilly evening at Cadiz, with the windows open; but at Burgos in a snowstorm—ugh!—it is an invention of the evil one, a very relic of the Inquisition. I shiver still at the name of it."[64]

Incidentally the use of the brazier in Spain, France, and Italy is attended with many fatalities caused by the carbon dioxide gas developed by the burning of charcoal in confined rooms.

A brazier of bronze having a foot, basin, and three spike rests projecting diagonally upward from the rim was found in a grave at Indian Hill, Ipswich, Massachusetts, by Charles C. Willoughby, director of Peabody Museum, Cambridge, Massachusetts. The specimen is supposed to be Spanish early sixteenth century. It was obviously not used for personal warming, but would serve for cooking and for warming water. The illustration shows two small holes cut in the wall of the vessel.[65]

---

[62] Harper's Dictionary of Classical Literature and Antiquities, New York, 1897, p. 19.

[63] Walpole. Four Years in the Pacific, London, 1849, vol. 1, p. 285.

[64] Spanish Facts and English Fancies, Lond. Illus. News, November, 1886, p. 79.

In Mexico particularly the brazier reached a marked development unaffected by European influences.

In speaking of the clan house, Fiske states: "A lighted brazier stood in the middle, and before tasting the food each person threw a morsel into the brazier as an offering to the fire god"[66] (pl. 8, fig.1).

Simple pottery braziers are still continued in use in Mexico. In a cliff dwelling of Arizona the writer discovered a coiled pottery bowl containing ashes and charcoal which was evidently a brazier[67] (fig. 1).

The fire pots and brazierlike fire containers which may be for either warming or cooking are considered simple stoves. They possess the essential feature of stoves, namely, the fire. Generally charcoal is the fuel burnt in them. They are in most cases baked earthenware, and the form is subject to individual and racial craftsmanship (pl. 8, fig. 3).

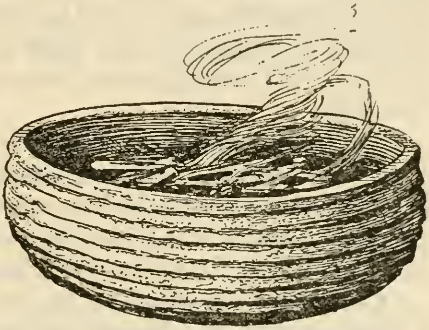


Fig. 1.—Pottery brazier, containing charcoal and ashes. Cliff Dwelling, Tularosa River, New Mexico

The Philippine pottery brazier is a graceful vessel with flaring rim and narrow foot, polished and decorated with stamp designs. It has several small round holes a short distance above the base, showing that some of the requirements for draught have been observed. This brazier was made and used by the Tagals of Union Luzon.

Accompanying the use of tea and tobacco are numerous minor uses of fire, which take their origin from the boxed-in fire and brazier. These have their highest expression in Japan, where art in utility is a characteristic. These consist in the simplest form of a tray of natural fine-grain wood having grasping openings on two sides. In this is placed a porcelain bowl half filled with white ashes, forming a bed on which the charcoal is placed. This form is really a small hibachi. Another form is a wooden box with handle having compartments for the fire, pipes, etc., and drawers for the tobacco. This outfit is designed to be carried about for the smoker's convenience.

---

[65] C. C. Willoughby. Indian Burial Place at Winthrop, Massachusetts, Papers Peabody Mus. Amer. Arch., vol. 11, No. 1, 1924, p. 22.

[66] John Fiske. The Discovery of America, vol. 2, 1892, p. 267.

[67] Culture of the Ancient Pueblos of the Upper Gila River Region, New Mexico and Arizona. Second Museum-Gates Expedition, Bull. 87, U. S. Nat. Mus., Washington, 1914, p. 3.

The hibachi proper is an indispensable belonging of the Japanese household. Commonly it is an earthenware cylindrical vessel, set in a deep wooden tray somewhat less in height than the vessel and provided with openings at the ends for lifting. A bed of fine ashes is placed in the vessel, on which is located the charcoal fire. Accompanying the hibachi are an iron trivet, a small shovel, a spatulate implement for smoothing the ashes, and a pair of slender pokers used as tongs.

In Japan there is in use a brazier called kotatsu, a pottery vessel set in a square wood frame. It is placed in the center of a sleeping room in very cold weather, and people sleep with feet against the kotatsu, over which is spread a quilt.

There have been in Mesopotamia cast-bronze braziers dating about the twelfth century, hexagonal in shape, with ornamentally pierced sides inclosing a bowl. The legs are formed by angle pieces riveted to the side plates, and raise the vessel several inches from the floor. Crescent ornaments on the upper edges of the side plates appear to represent the sacred horns, very ancient emblems of the powerful bull gods.

The Parsee brazier for the sacred fire is vase shape, of metal, and with drop handles. The metal tray for the sacred wood kindled by the heat of the fire in the brazier sets on top. As there are no provisions for draught and the tray serves to smother the fire, it is difficult to see how the sacred wood on the tray could ignite.[68]

Of the great antiquity of the brazier there can be little doubt, as a research into the history of the device will show. The brazier must, however, be placed developmentally in the period when relatively considerable advance in the arts of life had taken place, presumably not before the use of pottery.

The brazier is especially interesting in the history of the stove, of which it was the antecedent and which is discussed in the following section.

FLUE STOVES

The conduction of heat through flues for warming rooms by indirect heat radiation is an old device of uncertain origin, which is characterized by primitiveness in the East and advanced invention and art in the West. The Romans made extensive use of this principle, and it is said by Seneca, who flourished about the middle of the first century of the Christian era, that in his time a particular kind of pipe was invented and affixed to the walls of buildings, through which heat from a subterranean furnace was made to circulate.[69] The calida or furnace stove was known to the Romans and Greeks.[70] It is the hypocaust, which consisted of a furnace with flues running beneath the floors and in the walls of rooms and furnishing heated air for warmth. The indirect heat of the hypocaust was also taken into account by the Roman engineers in heating baths and houses, as in the brick stoves of Northern Asia and Europe.

---

[68] I. M. Casanowicz. Proc. U. S. Nat., Mus., vol. 61, 1922, art. 2, pl. 2.

[69] The Panorama of Professions and Trades, Philadelphia, 1946, p. 213.

[70] Smith's Dictionary of Classical Antiquities, p. 233.

Asiatic references give us what appears to be a primitive heating apparatus in use in North China and various parts of northern Asia. Ravenstein refers to this stove in the Amur region at the junction of Usuri, stating that the *khang* is a diwan or inclosed bench warmed by the smoke of the fire passing beneath it. The old-fashioned flues for warming greenhouses are on the same order.[71]

The k'ang is an economical device for warming. It consists of a horizontal subterranean flue forming a box in a room, in which fuel is burnt with a minimum of draft. "They sleep on kangs, rectangular mounds of earth and brick surmounted with a layer of cemented brick deep enough for a person to lie at full length. They are heated by a charcoal fire. The Chinese sleep on them without mattress, rolled in a thin quilt, and consider them vastly superior to our beds."[72]

Rockhill says that in the inns of Hsi-ning "the rooms are frequently without k'angs, having only copper fire pans in which they burn bricks made of coal and chopped straw. On the broad, flat rim of the fire pan stands usually a pot of tea and milk. When there is a k'ang it is often only a wooden box without any chimney or firing hole; the planks on top are removed when it is necessary to light it, and, dry powdered manure having been spread under it, a few live coals are put in and the planks replaced. The fire smoulders till all the manure is consumed, and the heat thus created is considerable."[73] In this case the slow combustibility of certain materials is utilized, as in the Japanese pocket stove and even in the cold frame for rearing plants.

The Russian, Scandinavian, and North German iron and brick and tile flue stoves are in the class with the kang as permanent installations for the slow radiation of heat. Their characteristic is the use of the flue.

The Russian stove is divided internally by thick fire-clay walls into several upright chambers or flues, usually six. Some dry firewood is lighted in a suitable fireplace and is supplied with only sufficient air to effect combustion, all of which enters below and passes fairly through the fuel. The heat passes through the flues and is absorbed by the 24 surfaces. When there is sufficient heat the chimney opening is closed and the fire put out, having done its day's work. The heat is radiated and produces a delightful temperature. The outside of the stove is covered with tiles of porcelain. The stove is sometimes built between rooms, or by a flue connects with a hall reservoir. These stoves cost from one to two hundred pounds. [74]

---

[71] Ravenstein. Russians on the Amur, London, 1861, p. 100.

[72] Women's Work for Women, May, 1888, p. 136.

[73] W. W. Rockhill. The Land of the Lamas, New York, 1891, p. 55.

The Scandinavian stove, commonly used in Sweden, Norway, Denmark, and North Germany, is a tall, hollow pillar of rectangular section, varying from 3 to 6 feet in width and rising half way to the ceiling of the room and sometimes higher. A fire is lit in the lower part and the products of combustion on their way upward meet with horizontal iron plates, which deflect them first to right and then left, and compel them to make a long serpentine journey before they reach the chimney. That heat is radiated from a large surface is the principle. It is also built between two rooms, perhaps between kitchen and another room, and is very economical. [75]

In Norway the tall, iron-flued stove superseded the great open fire with no chimney obtaining since ancient times.

In these countries the tile stove is an important feature of architecture, and sometimes the house is built around the stove, which is placed in the center and juts into four rooms. They are often elaborately decorated and very costly.

Both the tile and iron-flue stoves represent a great economy of fuel, and it seems unfortunate that they have not been introduced into the colder areas of North America, where sustained low temperatures extend over many weeks. A little wood is burnt in the stove once a day or twice a day in very cold weather. It is observed that the Russian stove merely ameliorates the room temperature and does not heat the air to a degree of positive comfort.

There are several reasons for the development of this kind of stove, severe climate, scarcity of fuel, state of advancement in housing arts, etc. In the high latitudes of the Western Hemisphere no such development has arisen. In a sense the Eskimo lives in his stove, represented by his nonconducting house, which the lamp and human heat radiations render often uncomfortably warm.

The northern Indian, by selection of place to camp, structure of his wigwam, and the possession of abundant fuel, accomplished the same protection.

COOKING

The history of the use of fire in cooking is of great interest. Two important facts appear in the study of cooking, and are seen in the variety of special inventions for the application of fire to the objects to be cooked and the many mechanical and technical devices accompanying these uses. The second refers to the far-reaching effects of the use of cooked food upon the progress of mankind, which offers a basis for an extended study merely to be suggested here.

---

[74] Condensed from M. Williams, The Englishman's Fireside, Science in Short Chapters, p. 218.

[75] The Englishman's Fireside, Science in Short Chapters, p. 219.

It is seen that the special inventions mentioned arise primarily in the stages of progress, and secondarily the increasing variety of processes are due to the substances to be cooked. For example, animal substances require certain technic, starting with those simple devices connected with the beginning of cooking, and vegetal substances, whose requirements for rendering the food edible are more complicated.

It is also apparent in the larger consideration of the subject that environment is a major factor in the character of the food supply and food habits. Schematically we may make a zonal distribution of food supply to man as follows: Arctic, animal; Temperate, mixed; Tropical, vegetal; South Temperate, mixed; and Antarctic, animal. "No strict lines separate these classes, so that in regions where it is commonly said that the tribes are meat eaters exclusively, vegetal food is also of importance, and vice versa.[76]

The following table gives the processes used in cooking and the devices coming under the various heads arranged in the suggested order of development:

CLASSIFICATION OF COOKING PROCESSES AND DEVICES

Roasting and broiling	Broche, skewer, animal in skin.	
	Spit.	
	Gridiron.	
	Grill.	
Frying	Flat stone.	
	Pan.	
	Deep fat vessel.	
Baking	Flat stone.	
	Pottery vessel with cover.	
	Oven	Hot stones on object.
		Clay cover.
		Pit oven.
		Reflector.
		Baker's oven.
		Dutch oven.
		Oven in range.
		Electric oven.
Boiling	Stones in basket.	
	Pot over fire.	
Stewing	Pot on range.	
	Steam jacket pot.	
Chafing	In can or steaming.	
Steaming	Over boiling water.	
Sunning	Exposure to hot sun.	
Electric	Above methods.	
Chemical	By lime.	

---

[76] Article, Food. Handbook of American Indians, Bull. 30, Bur. Amer. Ethnology, 1907, p. 466.

Another tabulation shows the application of heat in cooking:

APPLICATION OF HEAT IN COOKING

Direct heat	Roasting	Open fire.
		Broche and skewer.
		Spit.
		Gridiron.
		Plank.
		Reflector (direct and reflected heat).
Indirect heat	Frying	Frying pan.
		Deep fat.
	Baking	Hot stones.
		Stone slabs.
		Burying in coals.
		Coating with clay.
		Oven and pit.
		Sand bath.
	Boiling, stewing	Basket and hot stones.
		Pot.
		Stew pan.
		Chafing dish.
	Steaming	Steamer.
Dessication in sun:		
By heat	Sunning	In hot sun.
By air	Electric.	
	Chemical.	

The synoptic history of the development of cooking devices is shown by specimens in the United States National Museum. The course of development is as follows:

1. Broiling sticks. Stuck in the ashes of the fireplace; fish are spitted on them for broiling. Ainos, Japan. Broiling fork of iron. Sioux Indians, Dakota.

2. Gridiron. Set over coals for broiling meat. Colonial period. United States.

3. Frying pan of stone. Frying pan on small stove of earthenware. Korea and Portugal.

4. Baking dishes. Of soapstone; heated and filled with acorn mush, which is baked by the heat of the stone and before the fire. Hupas, California.

4*b*. Samoan pit oven. Alternate layers of food and hot stones are placed in the pit, covered over and allowed to bake.

5. Oven. Iron vessel with short legs, handle, and heavy lid, for baking by means of hot coals placed on top and underneath. United States.

6. Boiling basket. Food to be cooked is placed in the basket and heated stones are dropped in. This method is known as "stone boiling." Southern Alaska.

7. Pot for boiling. Earthenware; conical bottom. In use the pot is set up on stones. Zuni, New Mexico.

8. Tripod pot for boiling. Earthenware, with three legs, allowing the vessel to be set up in the fire. Zuni, New Mexico.

9. Coiled pot for boiling. Ancient vessel from the abandoned pueblos. Hopi, Arizona.

10. Shoe-shaped pot. Earthenware, small handle. In use this vessel was thrust in the ashes at the side of the fire. Hopi, Arizona.

11. Chafing dish. Combination stove for boiling and frying.

12. Rice boiler. Double vessel, the lower containing hot water to prevent the food from scorching.

13. Steamer. Double vessel, the bottom of the upper portion perforated and set over the lower vessel containing hot water. Used for steaming food.[77]

The continuation of the series belongs in the inventive period and is not illustrated.

Roasting and broiling.—There are introduced here the two simple and early cooking appliances, the spit and the grid widely used by tribes observed still retaining native conditions. Roasted food requires constant watching, boiled or baked food does not.

An extemporaneous spit which looks primitive is a stick upon which game is impaled and held over the fire. Rods definitely made for this purpose were first noticed in North America by the Raleigh expedition and figured by John White, the first painter of North American Indians. These were sticks sharpened at both ends for thrusting through fish or other game and into the ground against the fire. White portrays in the same drawing a grid with bars of wood for drying, smoking, or partially cooking various food supplies (pl. 9). The Natchez Indians of Louisiana also use spit and grid. In spitting large fish two rods were often used among the Kwakiutl Indians of British Columbia. The Carrier Indians at Stewart Lake, British Columbia, also roasted meat and fish in this manner. Among many instances of this method, the Roucouyennes of French Guiana roasted or dried game for transport on a grid of four posts with a rack.[78] The same device is generally used in South America. Under this class comes planking, which is not known to be aboriginal, but no doubt is an old method.

Parching.—Roasting is accomplished by the application of direct heat, generally to animal food. Through a loose use of terms roasting is applied to other methods of cooking, mainly of vegetal food. True roasting of vegetal food is seen in the roasting of corn and potatoes on the live fire. Parching has been called roasting, but is affected by indirect heat, as in parching corn. Lafitau says that it was the universal practice of the ancients to parch their grain before pounding it, as Virgil "fruges torrere parant Flammis et frangere saxo," "to parch the fruit (grain) and break (grind) them with a stone."

---

[77] Walter Hough. Synoptic Series of Objects in the United States National Museum Illustrating the History of Inventions, Proc. U. S. Nat. Mus., 1922, vol. 60, art. 9, pp. 1-47.

[78] Jules Crevaux. De Cayenne aux Andes, Le Tour du Monde, vol. 40 p. 1021^{e}; vol. 54, p. 68.

A method showing the use of small portions of fire is that of shaking grains in a vessel with hot coals. A basket is often used, and great dexterity is displayed in properly parching the corn without burning it or the basket. A hot stone is sometimes used. This method has been noted among the Cocopas of northern Mexico, some California tribes, and the Natchez and other eastern tribes. The Pueblo Indians parched corn by heating and stirring in a pot over the fire. Du Pratz says that the Natchez half cooked the corn in a pottery vessel and dried it before parching.[79]

Frying.—The Greek word *phrigo* means to parch. The word now may be confined to cooking with indirect heat, the utensils employed being a flat stone, griddle, frying pan, etc. Aboriginal methods where a dough of seed flour is put on a flat stone and cooked or in a concave stone dish or on a flat or curved worked stone are commonly termed baking, but are on the order of frying in its older sense. With vegetal food, as dough, mush, etc., the effect is to dry and harden in cooking, as in the bake oven.

In the use of stone we are here introduced to soapstone, the lapis ollaris, potstone, whose properties were much appreciated by all peoples who could procure it. Frying in the modern sense is cooking in a pan with grease in amount or with a little to prevent sticking. Soapstone does not require greasing. Frying in deep fat is effected by the high temperature of the medium. No material has been collected as to the antiquity of this method, but it was probably known to the Romans and other nations within the oil line of Europe.

Baking.—Food dried and hardened by cooking in an oven is said to be baked, according to definition, and the oven is an inclosed chamber in which food is cooked by indirect heat from the walls. Baking may be effected as stated under frying, without the oven, or by reflected heat in the reflecting oven stood before an open fire.

Interesting primitive or seemingly primitive devices which may be classed here under the oven are the incasing of birds, fish, or other small animals in clay and baking the mass in the fire. There is every reason for believing that baking under ashes is primitive. It is suggested in every open fire, and came down until recently in the roast potatoes and ash cakes of our near progenitors and is revived in the camp craft of the Boy Scouts. The Australians present a mixed method in which the animal is made the oven.

When a wallaby or other animal is killed they throw it whole upon the fire in order to singe it. Then a stone or stick is looked for to open it. They have no knives, and seem to be only in the beginning of the Stone Age. Hot stones are now put inside; after cooking a little it is divided, and each man goes on cooking his part over the fire and eating off the crust. Natives' teeth are worn off to the gums from constant use. They eat everything except leeches Australian vegetables are mostly poisonous, and have to be roasted and pounded between stones or soaked in water two or three days, and the result, a sort of dough, is eaten with the four fingers. Everything is eaten cooked with exception of the larvae of a beetle, and they will not eat anything that is spoiled. Lizards good. Opossums are mostly eaten. Grasshoppers are quite good. The larvae of a tree ant jarred out of the holes are eaten.[80]

---

[79] J. R. Swanton, Bull. 43, Bur. Amer. Eth., 1911, pp. 74, 75.

The earth oven or pit oven is both an ancient and widely distributed device for cooking. It may be divided into the heap ovens and pit ovens. One of the simpler forms of the heap oven is that of the Nutka Sound Indians described by Jewitt:

"When they cook their fish by steam, which are usually the heads, tails, and fins of the salmon, cod, and halibut, a large fire is kindled, upon which they place a bed of stones, which, when the wood is burnt down, becomes perfectly heated. Layers of green leaves or pine boughs are then placed upon the stones, and the fish, clams, etc., being laid upon them, water is poured over them, and the whole closely covered with mats to keep in the steam. This is much the best mode of cooking, and clams and mussels done in this manner are really excellent."[81]

This is the general method among the coast peoples and solves the problem of opening shellfish. The familiar clambake was adopted from the Indians. It will be observed that in the heap and frequently in the pit oven the cooking is effected by means of hot stones, as in stone boiling. The Chopunnish (Nez Perce) Indians of western United States used a similar method:

"The Indians prepared a large fire of dried wood, on which was thrown a number of smooth stones from the river. As soon as the fire went down and the stones were heated they were laid next to each other in a level position and covered with a quantity of branches of pine, on which were placed fletches of the bears (*Ursus horribilis*), the boughs and the flesh alternated for several courses, leaving a thick layer of pine on the top. On this heap was then placed a small quantity of water, and the whole covered with earth to the depth of 4 inches. After remaining in this state about three hours the meat was taken off. It was really more tender than that which had been boiled or roasted, though the strong flavor of the pine rendered it disagreeable to our palates."[82]

---

[80] Conversation given by Australian explorer, Mr. Lumholtz, at Anthropological Society of Washington, Dec. 17, 1889.

[81] J. R. Jewitt's Narrative, 1803, New York, 1816, p. 59.

A suggestion of the pit oven is seen in the method of roasting green corn among the Omaha Indians.

A trench is dug and a fire made in it and left to burn till there are plenty of coals. Corn is stripped down to its thin husks and put on the coals by women sitting at the sides of this trench. These women have to work quickly to tend the corn so that it will roast evenly. The ears are handled with the hands only. When roasted the corn is cut off the cobs and dried.[83]

"The Tlelding of California under stress of hunger ate soaproot (*Chlorogalum pomeridianum*), the poisonous properties of which they extracted by baking it in large quantities on the ground, covering it over with green leaves and building a fire over it, which was allowed to burn many hours, when the root is said to be sweet and palatable."[84]

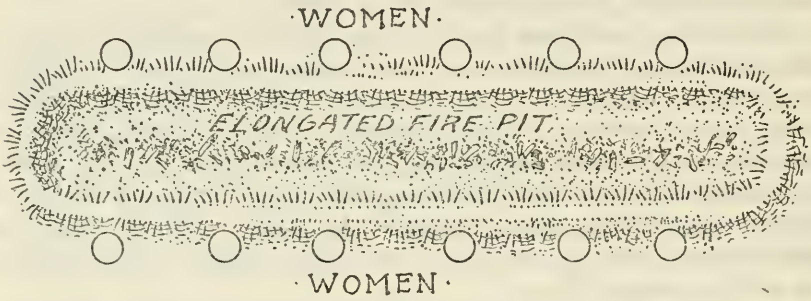


Fig. 2.—Corn roasting pit. Winnebago Indians

Capt. John Smith, speaking of the Powhatan Indians of Virginia, says:

"The chief root they have for food is called Tockawhoughe. . It groweth like a flagge in Marishes. In one day a Salvage will gather sufficient for a weeke. These roots are much of the greatnesse and taste of Potatoes. They use to cover a great many of them with Oke leaves and Ferne, and then cover all with earth in the manner of a Cole-pit; over it, on each side, they continue a great fire 24 houres before they dare eat it. Raw it is no better than poyson, and being rosted, except it be tender and the heat abated, or sliced and dryed in the Sunne, mixed with sorrell and meale or such like, it will prickle and torment the throat extreamely, and yet in sommer they use this ordinarily for bread."

The Pomos of California made a fire and put in stones to heat. When they were hot half of them were taken out and the remainder pushed together to form a layer, and were covered with a layer of oak and iris leaves. Acorn meal was then put on this layer, then a layer of leaves, and finally the remaining hot stones. Six inches of earth was piled on top and the heap was left to cook for six or eight hours.[85]

---

[82] Elliott Coues. Lewis and Clark Exped., New York, 1893, p. 1012.
[83] Information by Francis La Flesche, December 5, 1921.
[84] Stephen Powers. Contrib. North Amer. Ethnol., vol. 3, 1877, p. 89.

The type of pit oven in which the heating medium is hot rocks has been observed in many parts of the world. Even the western Eskimo cook and render harmless the roots of the wild parsnip in an underground oven with hot stones.

Maj. J. W. Powell records that the Ute Indians cooked grasshoppers with hot stones in a pit packed with layers of hot stones alternating with the insects. The grasshoppers were dried and ground for food.[86]

A pit oven for cooking new corn is employed by the Winnebago Indians. They dig a large circular pit 1 to 2 feet in depth, with flat smooth bottom, heaping the excavated earth in a ring around the border of the pit. A heap of new corn is piled near by and rocks are heated on a fire. Everything being in readiness, the hot rocks are piled in the middle of the pit and the corn heaped in, leaving a central hole down to the rocks. Earth is covered over the mass and water poured down onto the rocks, producing a tremendous volume of steam. The pit remains closed for several hours[87] (fig. 2).

The Pomo extracted the poisonous principle from buckeyes by steaming them underground for two or three days. They first excavate a large hole, pack it water-tight around the sides, burn a fire therein for a space of time, then put in the buckeyes with water and heated stones and cover the whole with a layer of earth.[88]

The roasting of the fleshy leaf bases and trunk of various species of agave was an ancient custom of the Mexicans, and is continued to this day among the tribes of the southwestern United States and Mexico. The oven is a cross between the heap and pit oven, is circular and from 6 to 20 feet in circumference and slopes evenly to the center, 1 to 3 feet in depth, and is packed with a fire bed of coarse gravel or medium-sized stones. A fire is built on the pit, raked over after the stones are hot, and the pieces of agave plant put in and covered with grass and earth. After two days' cooking the pile is opened and the mass ready for consumption. The baking rendered the acrid agave very sweet. At Tequila, Mexico, the writer observed the agave roasted with wood, to produce after fermentation a spirituous liquor with a smoky flavor.

Among the Maori of New Zealand food was generally cooked in the earth oven. This consisted of a hole in the ground in which a fierce fire of dry wood was kindled, and upon the wood was set a number of large stones not liable to crack with the heat. When the stones had become red-hot they fell through the fire as it burnt down and were then taken out with rough sticks used as tongs and set aside. The ashes were taken from the hole and the hot stones replaced; upon these were set green leaves and the food laid on them. Edible roots and tubers were laid at the bottom and meat or fish on top. The meat to be cooked was bound up in large leaves to keep the gravy in. More green leaves were placed over the top and then water poured over, the whole being quickly covered in with old mats soaked in water and with soil hastily heaped on so that the steam could not escape. After some time, generally about one and a half hours, the oven was carefully opened, the coverings lifted off and the well-steamed food taken out. The result was extremely good, and although almost the only practical mode of cooking known to the Maoris, there was no complaint as to efficiency. Of course they knew how to cook birds or fish by broiling or toasting before the fire on a stick, but this was seldom attempted on a large scale. Not having utensils of metal, frying and boiling or baking was not attempted.[89]

---

[85] J. W. Hudson. Amer. Anth., new ser., vol. 2, 1900, p. 775.

[86] J. W. Powell. Exploration of the Colorado River of the West, Washington, 1875, p. 128.

[87] Information by Francis La Flesche, Dec. 5, 1921.

[88] Stephen Powers. Cont. Amer. Ethnol., vol. 3, 1877, p. 150.

Queensland baking ovens are thus described by Walter E. Roth:

"It will be noticed in the accounts of the different animals and birds utilized for food that they are all eaten roasted—that is, cooked on the ashes. A modification of the process, it may almost be called 'baking, is effected as follows, and may be met with throughout northwest central Queensland: A pretty large fire is made and a number of biggish-sized stones rendered as hot as possible; at the same time a hole is dug close alongside and some of these hot stones put in to line it. The 'meat,' whatever it is, is now put in and covered over with another layer of hot stones, to be followed by a 'hide' of some sort, and a final covering of mud, the whole constituting a kind of primitive bakehouse. It is used especially for any very large-sized piece of flesh, emu, kangaroo, bullock, etc."[90]

R. H. Matthews says that stone cooking holes were used by the Australian aborigines.[91]

The breadfruit area, much extended by the Polynesian navigators, is characterized by the pit oven. In some cases water is poured in on the hot stones, as among the Maori, and in some localities this custom is not followed. The Polynesians were skilled in the use of the pit oven, and pigs and all sorts of other food were cooked as required.

One type of pit oven does not require the use of heated stones and is an advance on the other type. The simplest form of this oven is found among the Yurok Indians of California, who poured uncooked acorn meal into small sand pits dug in the river bank, around which a fire was made until the meal was cooked, then the outside sand was brushed off and the bread was ready to be eaten.[92]

---

[89] Edward Tregear. The Maori Race, Wanganui, New Zealand, 1904.

[90] Walter E. Roth. Ethnological Studies Among the North-West-Central Queensland Aborigines, London, 1897, pp. 104–105.

[91] Journ. Anthrop. Inst., vol. 55, 1895, p. 225.

The Cora and Huichol Indians of Mexico use the heated earth oven without rocks. "When a deer is killed and can not be consumed fresh, the carcass is placed in a large hole in the ground, which has first been thoroughly heated, and then covered with grass and branches; the meat thus becomes slowly and thoroughly baked."[93]

In 1903, in mounds north of Chillicothe, Ohio, W. C. Mills discovered traces of a great clambake, in which it is estimated 10,000 mussels and game were baked in a pit 4 feet in diameter and 10 feet deep. This was a heated wall pit in which no hot stones were used, and is thus of the Pueblo type. The latter are community ovens consisting of a bottle-shaped cavity excavated in the ground and provided with a draught hole. In these great quantities of green corn ears were cooked. The method was to heat the pit, the draught hole assisting combustion. When the pit was heated the fire was drawn and corn piled in and the pit closed for 12 hours. The opening of a pit was the occasion of much festivity. Small family ovens with a draught hole, and others consisting of merely a coarse cooking jar set in the ground covered with a stone, are used by the Hopi for cooking mush. The Zuni also have several forms of ingenious pit ovens[94] (pl. 22, figs. 6, 7).

In the above ground oven we approach the modern developement of this important domestic adjunct in which true baking is effected. The form seen around the Mexican villages and eastern pueblos of the southwestern United States are conical or dome shape, the walls of clay several inches in thickness. It has a door at the ground level and a draught hole near the apex. In use it is strongly heated with wood fuel, and when the fire has burned out the ashes are swept away, the bread placed in the oven and the aperture closed. This form of oven is an introduction into Spanish America through Spain, though it resembles in some respects the Mexican temescalli or sudatory. It is much more satisfactory than the pit oven and the Pueblos who have adopted it regard it as of native origin. The Zuni have a religous functionary called the Demon Inspector of Ovens, who on a stated day yearly with broom in hand, inspects the ovens of the pueblo and inflicts a penalty on those householders whose ovens are dirty. The modern Syrian oven is of this type, but is usually built against the house. The ancient oven of Biblical times was a curious inversion. It was a hollow cylinder of clay with lid. The bread was placed on the floor therein and a fire of dung laid outside. The Jewish oven of Biblical times therefore was technically much like the modern oven forming part of our stoves. The character of the fuel no doubt prohibited the use of the dome oven described previously.[95]

---

[92] Stephen Powers. Cont. Amer. Ethnol., vol. 3, 1877, p. 49–50.

[93] Ales Hrdlicka. Physiological and Medical Observations, Bull. 34. Bur. Amer. Ethn., 1908, p. 26.

[94] Frank H. Cushing. Zuni Breadstuff, vol. 8, 1920, Indian Notes and Monographs, Museum of the American Indian, Heye Foundation, p. 304.

Culinary operations about the great fireplaces of Europe were always attended with difficulty, especially with regard to small bakings. This was effected by baking of trenchers, scones, and the like on an iron plate and in metal vessels with lid upon which hot ashes could be placed. A familiar example of this is the cast-iron spider with heavy lid and bail or handle, called Dutch oven so useful in pioneering. In the colonial times several shapes and sizes of ovens of this kind for baking hams, turkeys, etc., were employed.

The large bake oven installed in a bakehouse or built in as a unit of the dwelling prevailed in Europe for many centuries, and was introduced into America by colonists, especially those from north Europe. In Pennsylvania, Virginia, and the South an occasional old "Dutch oven" may be seen about the old homesteads.

In connection with baking a further consideration is necessary in regard to baking without the oven. Mention has been made of baking on slabs of stone laid on the coals or raised with fire beneath or variously installed, culminating in the griddle. Generally this type of baking received its greatest impetus in the agricultural period where ground grains or other vegetal food mixed in the form of mush or batter were to be cooked. Examples are also common in the pre-agricultural stage, as notably in the acorn area of California (pl. 10, fig. 2). Here acorn mush was baked on the fire in soapstone dishes. In advance of these dishes are the curved slabs of soapstone recovered from ancient sites at Santa Barbara, California, which were pierced with a hole near the edge to facilitate pushing in and pulling out of the fire with a hooked stick (pl. 10, fig. 3). Batter breads must be thin in order to bake properly. The Pueblos mount a smooth stone slab as the top of a rude stove, below which a fire is built, and spread the batter on in a thin layer with a trained hand. The baked product is a thin sheet like paper, which is rolled up in a bundle for consumption.

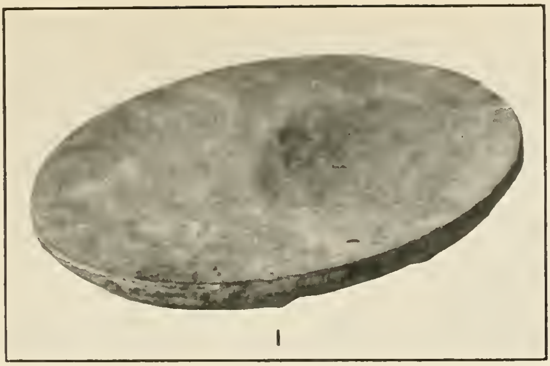
The Mexicans use a stone or pottery griddle for baking tortillas the north Africans employ a circular stone griddle, and so on (pl. 10, figs. 1, 5). The Iron Age ushered in more durable and serviceable devices of this kind.

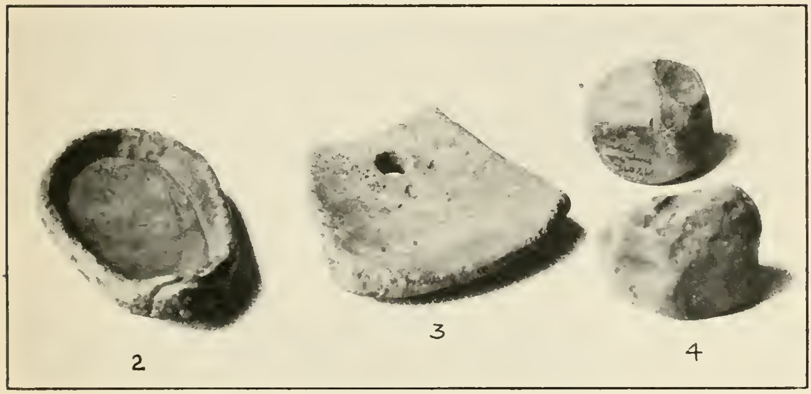
STONE BOILING

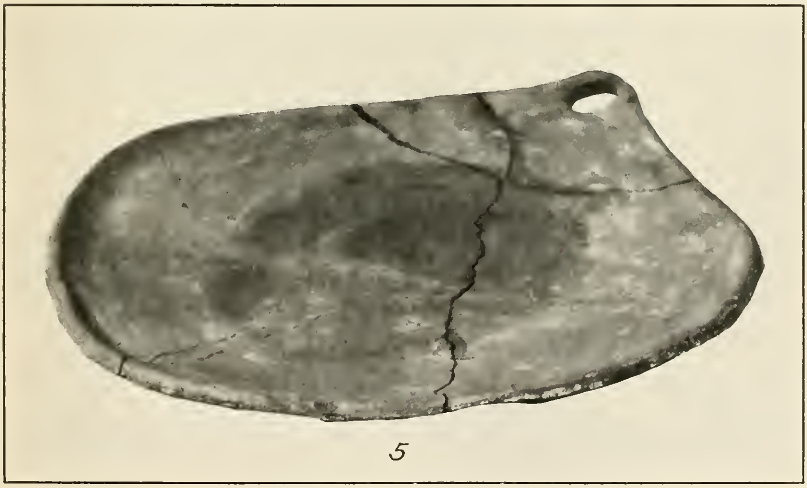
The process of boiling is intimately connected with vessels for boiling, and thus is not conceived of as a primitive method. Be-

---

[95] George A. Barton. Archeology of the Bible, Philadelphia, 1907, p. 149.



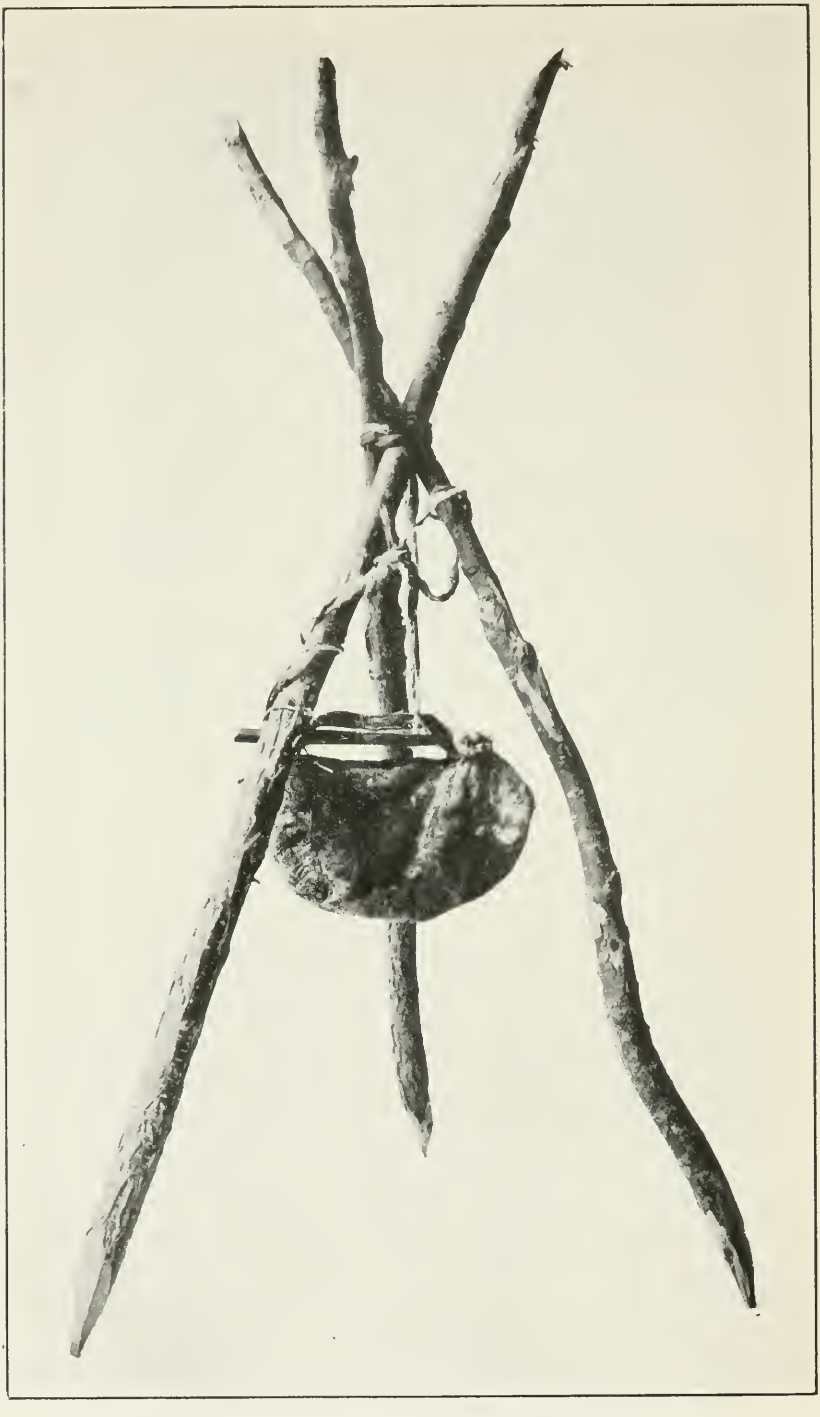




Baking Slabs of Pottery and Stone

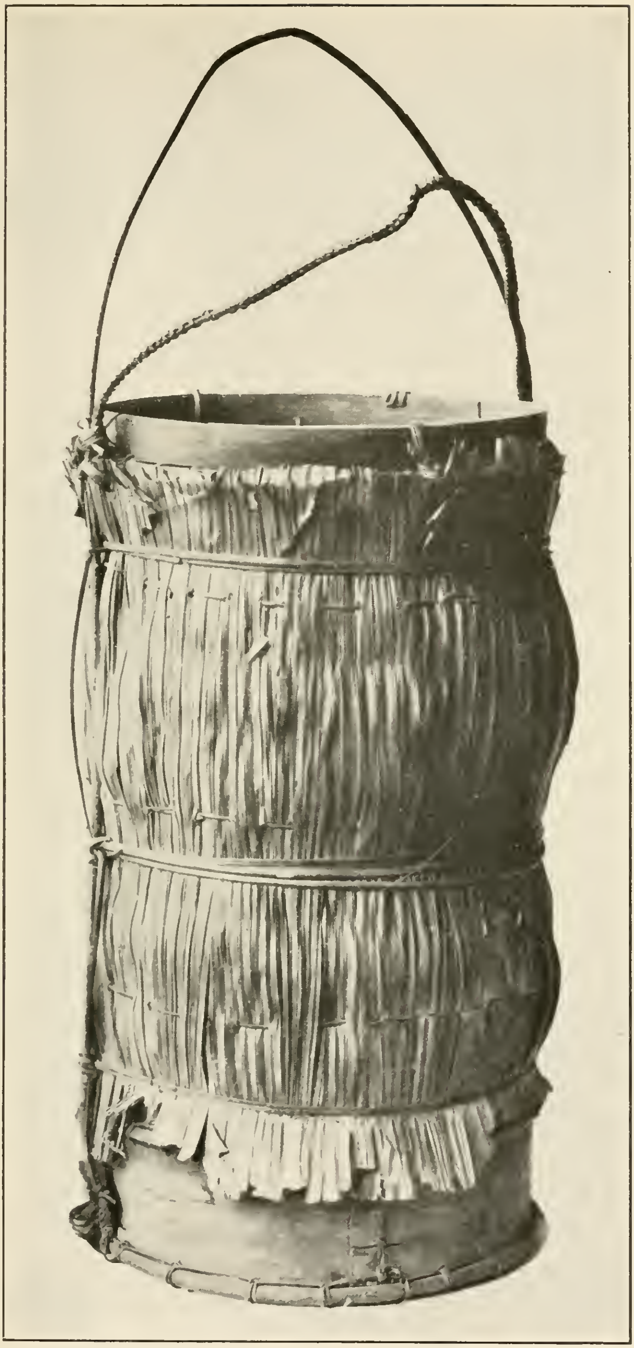
1, Tetuan, Morocco; 2, 3, Soapstone dish and slab, the latter ancient, from California; 4, Stones for stone boiling, Lower California, Mexico; 5, Pottery tortilla baker, Mexico

For description of plate see page 40



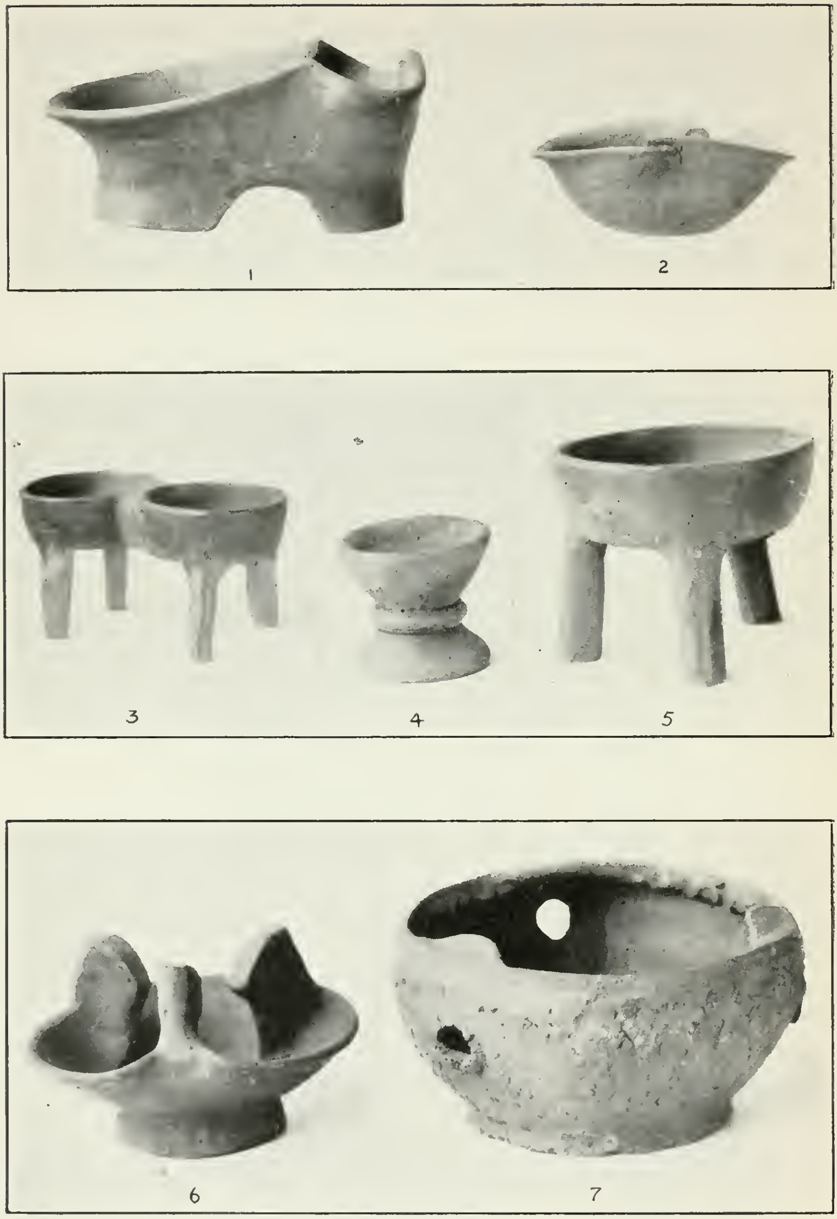
Paunch on Tripod for Stone Boiling. Teton Sioux

For description of plate see page 41



RICE STEAMER. SIMALUR ISLAND, EAST INDIES

FOR DESCRIPTION OF PLATE SEE PAGE 43



SIMPLE STOVES

1, 2, Stove and pot rest, Philippines; 3, Double brazierlike stove with legs, Philippines; 4, Brazierlike stove from Laos, French Indo-China; 5, Pot stove with legs, Philippines; 6, Pottery stove with high pot rests, Philippines; 7, Stove pierced on side, Tetuan, Morocco

FOR DESCRIPTION OF PLATE SEE PAGE 47

cause some Indian tribes,[96] as the Assiniboine and other tribes in various parts of the world, as a matter of exigency dig a hole in the ground and line it with the green hide of an animal and boil with hot stones food in this ingenious but extemporaneous vessel, the theory has been advanced that early cave men may have used this method. This is conjectural. Robert H. Lowie says in regard to the Assiniboines:

"When the men were on the warpath they dug a circular excavation, which was lined with a skin pegged to the bottom of the pit. Holes were cut along the rim of the hide and stakes were run through them. Then water and meat were put in, while other men heated rocks. First a rock with a rawhide loop around it was used to stir the water, then red-hot stones were dropped in until the food was boiled. The women are said never to have employed this method of cooking; with them the normal method of preparation was to roast meat on a spit planted obliquely over the fire. When necessary the food was spread out by means of horizontal pins."[97] It was long thought that the name of this tribe should be translated "Stone Boilers" but the meaning is *bwani*, coward, and *assini*, stone.[98]

Two stones definitely used in stone boiling are shown in Plate 10, Figures 4, 5.

The National Museum has a specimen of the outfit used by the Teton Sioux Indians in cooking meat of an animal in the animal's paunch, collected by Miss Frances Densmore[99] (pl. 11).

The use of heated stones for boiling is a mode of the application of heat which seems to have considerable antiquity. The use of hot stones in connection with the oven has been mentioned. Hot stones for boiling liquids and cooking food has, like the oven, a wide distribution. It would seem that this is probably the first method known to man for storing temporarily and transferring heat, and knowledge of this kind could well be acquired at the first fire. The vessels in which stone boiling is practiced are skins of animals, water-tight baskets, wooden boxes, wooden bowls, soapstone pots, bark vessels, bamboo tubes, and gourds.

In 1610 the Indians of eastern Canada made cooking pots of bark. They dropped hot stones, one after another, into these pots full of water and meat until the meat was cooked.[1]

Gilpin definitely says that the Micmacs of Nova Scotia made pots and kettles of birch and pine bark in which water was heated by throwing in hot stones. They also made coarse clay pots. Fish were impaled and set up on forked sticks before the fire, and bones were roasted and the marrow extracted.[2] These methods were duplicated by the Eskimo of Icy Cape:

---

[96] George Catlin. Eight Years, vol. 1, London, 1848, p. 54.

[97] Robert H. Lowie. The Assiniboine, Anthrop. Paper, Amer. Mus. Nat. Hist., New York, 1909, p. 12.

[98] Information by J. N. B. Hewitt.

[99] Bull. 61, Bur. Amer. Ethnol., p. 399.

[1] Jos. Jouvency. Jesuit Relations (Thwaites), vol. 1, 1918, p. 285.

"In boiling, for they had not seen metal kettles, they used those neat birchwood tubes prevailing throughout Canada. Filling the vessel with water, they cast in red-hot stones until they effected the object of boiling; on this they placed the object and all within a tub so as to prevent the escape of the steam.

"Their modes of cooking at the period to which I allude were very simple. A salmon, split and traversed by seven or eight skewers transversely, was again threaded in and out, longitudinally, by a long spit. This, stuck into the ground and inclined over the fire, caused the hot fat from the tail to run down the sides and cleanly and effectually roast the whole fish fit for any epicure."[3]

The Dogrib and Slave Indians of Canada practiced stone boiling in baskets of spruce root.[4] The Hong Kutchin of Canada cooked by this method, using baskets woven of tamarack roots.[5]

The Kwakiutl Indians used well-constructed rectangular boxes for stone boiling, and the Tlingit used both baskets and boxes. The coast Salish and Thompson River tribes employed strongly woven baskets. Many of the California tribes cooked acorn mush in baskets. The Arikara Indians made water-tight cooking baskets. There is a reference to boiling with hot stones in calabashes among the Indians of the lower Rio Grande, Texas, mentioned in Naufragios of Cabeza de Vaca.[6] The following is a free translation:

"They do not have pottery ollas, and to cook that which they wish to eat fill half of a large calabash with water, and in the fire put many stones of the kind that can be best heated in the fire; and when the stones are hot they take them up with tongs of wood and throw them in the water in the calabash that it may boil with the heat contained in the stones; and when the water boils they put in what is to be cooked, and from time to time they put in other heated stones to keep the water boiling to cook what they wish, and so they cook." The Zuni Indians sometimes used the stone boiling method.[7]

One of the Zuni methods was to cook in a pit mush spread between heated stone slabs, giving an interesting variant of the pit oven and stone cooking.

---

[2] Edwin Gilpin. Proc. Nova Scotia Inst., vol. 3, 1874, p. 222.

[3] Sir E. Belcher. Works of Art by the Eskimo, Trans. Ethnol. Soc. Lond., new ser., vol. 1, 1861, p. 133.

[4] Alexander Mackenzie's Journey, 1801, p. 33.

[5] Smithsonian Report, 1866, p. 322.

[6] In Oviedo. Historia General, p. 608. Bandelier, Arch. Inst. Papers, American Series 5, Cambridge, 1890, p. 59.

[7] Frank H. Cushing. Zuni Breadstuff, Indian Notes and Monographs, vol. 8, Museum of the American Indian, Heye Foundation, New York, 1920, pp. 254-255. This excellent work describes charmingly the elaborate Zuni cuisine.

In the Solomon Islands vegetables were boiled in deep wooden bowls by means of hot stones.[8]

Further references to stone boiling are given in Tylor's Primitive Culture, where the subject is excellently treated. A modern survival of the stone boiling method is seen in the scalding of hogs to remove the bristles, practiced on the farms at butchering time. The warming of liquids with a hot poker may also be mentioned.

Steaming.—This quite indirect application of heat for the softening and cooking of food is limited in extent among uncivilized peoples, but is an important feature of modern cuisine. In America but one reference is found this method, namely, to its use by the Zuni Indians of New Mexico in making stewed dumplings. Cushing says:

"Fine flour was boiled in water until paste had been formed. Into this paste enough meal was mixed to make a stiff dough, and of this dough little balls or pellets were rolled out and spread evenly over a yucca sieve or screen of sticks connected at the ends. A large pot half filled with water was set over the fire, inside of which a smaller vessel, partially filled with water and weighted with pebbles to keep it steady was placed. Upon this smaller pot was laid the sieve or screen holding the balls of dough, the larger pot then being covered with a slab of stone and kept boiling until the dumplings were thoroughly cooked by steaming."[9]

Rice particularly lends itself to steaming, and it is in the rice-growing area that a utensil designed for the purpose is prevalent. A specimen of rice steamer, angoo kooyan, from Simalur Island, East Indies, collected by Dr. W. L. Abbott, may serve as the type (pl. 12). It consists of a cylinder of bark hooped and sewed with rattan, having one-fourth way from the bottom rim a grating of rods, the sharp ends thrust into the walls of the cylinder. In use a leaf is spread over the grating and rice put on top and the whole put over a pot of water. The top of the cylinder is kept covered. Another specimen is from the Orang Talang, Mandau River, Siak, East Sumatra. The Malay name is "*koksissan palat.*" It is a cylinder of bark strongly bound, and has near the bottom a rod grating, entire, resting on a ring support. The grating has attached to it three rattan splints, so that it can be drawn up to the top of the cylinder in taking out the cooked rice. The steamer is provided with a rattan bail. The exterior of the vessel is padded with a layer of palm leaf to conserve the heat. It is 51 centimeters high and 28 centimeters in diameter.

It will be observed that in the pouring of water on the hot stones preparatory to covering in the pit oven there is a suggestion of steaming. The cooking of green vegetables in a pit oven tends to produce steam which assists in baking, but this is incidental to the process.

---

[8] C. M. Woodford. Among the Head Hunters, London, 1890, p. 29.

[9] Frank H. Cushing. Zuni Breadstuff, 1920, pp. 299-300.

Steam cooking is a very important branch of modern food preparation. The steamer for domestic use differs little from the Malay apparatus. For large uses the engineer has done his part.

Sunning.—While not requiring any apparatus and only remotely connected with cooking as commonly defined, sunning really accomplishes some of the purposes of the use of fire. The process is seen in the sun drying of animal and vegetal food for preservation, in which the action of the sun's rays performs other offices than drying the tissues. It is found in modern practice that exposure of fresh fruit in glass jars to the rays of the sun is as efficacious for preserving as the water bath or boiling.

Cooking by absorbed heat under conditions of good insulation is effected by the fireless cooker. With the adjuncts of heated irons or stones, the resemblance to the pit oven is apparent. The preservation of heat by insulation has long been known, and the efforts to prevent loss by radiation has occupied engineers and inventors and has produced a remarkable series of devices. The classical reference in Juvenal's satires to the custom of the Jews of keeping food warm over the Sabbath in baskets of hay suggests the hay cooker, which preceded the fireless cooker.

BOILING

Boiling is accomplished through the indirect application of heat by means of water. It may be described as a tertiary application of heat. We have here again the question of vessels which will not break under the action of fire. This exigency was first relieved by the invention of pottery in the Neolithic.

They did not boil food in the Homeric Age, but they heated water in a brass kettle, according to Virgil (in lines following 176 in B. 1), who may have introduced a custom of his own times.

With the introduction and working of metals boiling was much facilitated. There were, however, soapstone vessels in localities where this material was available, as at Santa Barbara, California, where many well-preserved specimens of ollas have been taken from ancient sites containing no traces of pottery. Soapstone pots with thick walls from archeological sites in the eastern and southern Indian areas of the United States always occur with pottery, and it is not certain that they were used for boiling. The Eskimo cook in soapstone pots of rectangular bowed shape suspended over the lamp. The Bering Strait Eskimo used pottery vessels for cooking food.

The Carriers (Athapascan) of Stuart Lakes, British Columbia, roasted meat or fish on a wooden spit passed through and stuck in the ground near the fire, or later boiled in a kettle supported over the flame on a cross stick set up on crotches.[10]

The American Indians generally, except in the portions of California and in the Plains where the potter's art was unknown, cooked in earthenware vessels and had developed a type of paste in making the vessels which was resistant to fire. The method of coiling, producing a rugose surface, also prevented cracking on the fire.

The older authorities stated that the Natchez Indians of Louisiana only boil and roast their food.[11]

For boiling small portions of water or food the Hopi and some other Pueblos use a sock-shaped vessel of coarse pottery which can be thrust point into the fire. Specimens of this vessels are often taken from the ancient sites. This form of vessel has been found in archeological sites in Central and South America, but not definitely known to have been used in cooking.

The women of the Soumoos or Woolwas of Bluefields, Nicaragua, busy themselves at the fires, from time to time in stirring the contents of large earthenware pots with long-handled spoons, or in toasting green plantains, turning them with tongs of bamboo.[12]

A. H. Keane states that "the Botocudos cook their food in huge bamboo canes, which can be made to hold boiling water.[13]

A striking example of savage ingenuity which is suggestive of one of the primitive beginnings of pottery is furnished by the natives of Bhutan, who plaster clay around the base of a bamboo tube before putting it on the fire for boiling the contents.[14]

At Port Moresby, New Guinea, most of the Motus have their eatables boiled in earthen jars, whilst the Koitapu cooks his in an earth oven.[15]

The Polynesians not having pottery and the Melanesians having it unequally distributed, determines the custom of boiling in these areas.

In Africa boiling is practiced by tribes possessing pottery. On page 123 of the Specimens of Bushmen Folklore, in a description of a controversy between a hyena and a lion, the following paragraph describes the use of pottery for cooking:

"Therefore, the Hyena gave soup to the Lion; therefore, the Lion took hold of the pot, while the pot was hot; the Hyena also grasped the pot with his hands; the Hyena said: 'O Lion! Allow me to pour soup into the inside of thy mouth.' The Hyena poured soup into the Lion's mouth; then he put the mouth of the pot over the Lion's head, while the pot was hot; the soup was burning the Lion's eyes; the soup also burned the inside of his mouth. When he swallowed hot soup with his throat, etc."

---

[10] A. G. Morice. Trans. Canad. Inst., 1892–93, vol. 4, p. 187.

[11] J. R. Swanton. Indian Tribes of the Lower Mississippi Valley, Bull. 43, Bur. Amer. Ethnol., 1911, pp. 72–73.

[12] H. A. Wickham. Journ. Anthrop. Inst., 1894, vol. 24, p. 200.

[13] A. H. Keane. Man: Past and Present, Cambridge, 1899, p. 437.

[14] Narrative of the Mission of George Bogle to Tibet, 1876, p. 21.

[15] E. Way Elkington. The Savage South Seas, London, 1907, p. 23.

The following extract, taken from page 347, further demonstrates the use of clay pottery for cooking:

"The wife goes to pour the blood of the springbok into the new pot. And she boils the blood; and, when the blood is cooked, she takes the pot off the fire; she takes the blood out of the pot (with a springbok horn spoon), and she sets the pot down; because she wishes the blood (i. e., the blood remaining in the pot) to dry.

"And she again takes the pot, and she puts water into it; she boils meat.

"And, also, they do not strike with a stone when a new pot is on the fire, because they wish it not to split."[16]

The Shom Pen, Nicobar Islands, use, according to E. H. Man, a unique method of boiling by placing bark vessels in direct contact with the fire.[17]

Dr. S. P. Verner, in a note on a National Museum specimen of bark called *chipsu* from the Baluba, Upper Congo, Africa, states "that the inner bark of a large tree is used for making a vessel in which things are boiled over an open fire; especially in evaporating the lye from grass ashes, leaving the sedimentary salt so largely used in central Africa in place of sodium chloride."

DEVELOPMENT OF THE COOKING STOVE

The introduction and use of certain classes of foods, especially vegetables, and the kind of fuel give rise to modifications in the stôve, the outgrowth of needs of stoking and cooking. Corn compels changes and inventions in cooking, as the oven, and cassava likewise makes demands.

In the discussion of andirons it was mentioned that this device begins in the supports placed in the fire for various purposes, depending on the state of advancement in culture. It may be said also that this primitive device marks the beginning of the stove, and that it is present in many of the simple stoves described in this chapter, as the three supports for cooking vessels. This statement is not stressed, because supports are such an obvious necessity that their use would be automatic. The use of not less than three supports is also required for stability, but more supports could be used. In several ancient sites in New Mexico, at Luna, the Tularosa River, and other stations in the region, triangular burnt-clay fireplaces have been unearthed, both in open-air villages and in cliff houses. They are in one piece and consist of three bosses rising from a base. These are suggestive of a beginning stove (pl. 2). Sometimes even an elaborate stove, as the example from the Philippines, presents the primitive pot-rest installation (pl. 14).

---

[16] W. H. I. Bleek, Ph. D., and L. C. Lloyd. Specimens of Bushman Folklore. Edited by the latter. London, 1911.

[17] E. H. Man. A Brief Account of the Nicobar Islanders, Journ. Anth. Inst., Great Britain and Ireland, vol. 15, 1886, pp. 433–444.

It is evident there are many lines leading to the complicated stove of modern times. The modern coal stove is a combination of a number of devices used independently at various stages of progress. The grate is the ancient grid, the fire box is a closing in of the open brazier, the air box and ash receiver are seen in simple stoves, the holes are out of the primitive boss supports, and the top represents the baking slabs. The oven has been added; the water heater has ancient prototypes. The draught devices are improvements on the early rude attempts to increase the heat, beginning with the fire fan. The stove, which was first a fireplace with only a fire, received walls to confine it, a lid over the top, a flue, and then is added a broiler. A baking oven, which began in the field, is combined with the previous inventions, a chimney is added when the stove is taken into the house, sundry doors, flues, dampers, grates, etc., attach themselves, and we have that paragon of domestic utility, the range.

Simple stoves without draught.—The simplest portable stoves are of the brazier type, without any provision for draught and without hearth (pl. 13, figs. 3, 4, 5). Simple modeling of the clay in formation of the utensil in order to provide supports for the cooking vessel differentiates the stove from the brazier, the latter being a normal bowl. An example is seen in a pottery stove from the Philippines, which consists of a bowl with punched-in sides (fig. 2), and more modified (fig. 1). The potter has produced by this simple means a support for a pot. Another specimen from the Philippines is of pottery and has three high supports formed on the sides of a bowl, making an effective pot rest (fig. 6). Bowl stoves from Occidental Negros, Philippines, are given three feet, like the Mexican tripod wls.

Simple stoves with hearth.—Most of the rudimentary stoves are provided with a hearth (pl. 15, fig. 2). The hearth extends out before an opening which will stand for a door, and thus there is a suggestion of improvements leading to draught (pl. 15 fig. 3). A Siamese pottery stove with hearth has one formed boss at the back, and the other supports are the points of the cut-out fire bowl. Another, from Sumatra, is of pottery, triangular in shape with base. It has three hook bosses or supports at the rear around the fire bowl. From Occidental Negros, Philippines, comes a bowl stove mounted on a base. It has a projecting hearth and has three bosses stuck on inside the fire bowl. Another from the same locality has three bosses on the rim of the bowl. A specimen from San Fernando, Union, Luzon, Philippine Islands, is a pottery oval bowl decorated with stamped patterns and having three bosses at the rear. It is called "*calan con banga.*" From the same city is a simple pottery stove consisting of a flat base extended to form a hearth and with curving sides forming an effective continuous pot rest. A heavy pottery stove of triangular shape is used in the Philippines. It has three large bosses in the middle of the equal sides and smaller bosses at the angles. It will be seen, therefore, that a large pot and three smaller pots may be set over the fire in this geometric stove. This stove is one remove from the three-legged iron pot rest from Morocco in that it has a bottom while the trivet requires the earth for a fireplace. Sven Hedin describes a similar iron trivet with pot supports in use among the Mongols of Tsaidam.[18] Pottery stoves from Tebessa, Algeria, consist of a fire bowl with semilunar portions of the rim removed, giving three supports for the cooking pot, the latter having lugs and a flat bottom.[19] The Hindu pottery stove is shaped like a metate with four legs, and the fire is built on the ground underneath. A projection of cup shape with four pot supports is for small cooking. A more elaborate old Hindu portable stove (*angithi*) is in the Taylor collection, South Kensington Museum, London. It is of iron and brass openwork with chains and handles. Fire is placed in an eight-sided vessel which rests on three curved legs, and an eight-sided rim of pierced work enables cooking vessels to be placed over it.[20] Draughtless stoves, called *mangal*, of pottery are in use in Egypt. They are constricted near the base and widen toward the top. They resemble the pottery stoves excavated at Der el Ballas, a specimen of which is in the Museum of the Affiliated Colleges in San Francisco, California. This specimen has three triangular holes cut through the wall of the vessel near the rim.

Stoves with rudimentary draught.—Dr. and Mrs. Talcott Williams collected in Morocco a rude, coarse pottery bowl having three pot supports inside the rim. It has three holes punched through the sides above the fire line. It is described as "a Majmar Arab vessel used to light charcoal fires in the village fair of Beni Ogerba, near El Usted, Morocco" (pl. 13, fig. 7). A similar pottery stove bowl mountedon three legs from Mexico (pl. 15, fig. 1). The upper portion of the bowl is pierced with two squared openings and two slashes. The border of the rim on which the cooking pot rests is scalloped. A simple pottery bowl stove from Java has a fire hole cut in the side, which in use would give some draught.

---

[18] Through Asia, vol. 2, 1899, p. 1086.

[19] Le Tour du Monde, vol. , 1880, p. 17.

[20] Catalogue of Objects of Indian Art, 1875, p. 292.

Stoves with under draught.—A pottery stove model from Caracas, Venezuela, has a cylindrical base containing the air chamber. The fire bowl is perforated in the bottom (pl. 16, fig. 6). A similar speciman from Guadalajara, Mexico, has a fire bowl with perforated bottom mounted on a base forming the air chamber furnished with an opening (pl. 16, fig. 2). Another specimen is from the Indian town of San Pedro, Mexico (fig. 5). The Porto Rico pottery stove has the air chamber in a hollow base and the fire bowl has a grate and lugs; collected by Paul Beckwith (fig. 4). From Tangier, Morocco, comes a stove cut from soft stone. The air box is in the base; the fire box is circular, with grate bars cut in the bottom. There are four low bosses at the corners of the fire box for pot rests; collected by Talcott Williams. A Spanish stove, *hornilla,* is made of white clay and has four legs, an air chamber and a fire pot with iron bars; collected by the writer in Madrid (fig. 3). A model bowl stove with side cut out is from Java (fig. 1). An earthenware coal pot, *soufriere,* from Santa Lucia, was collected at the Jamaica exposition of 1891. It is of terra cotta, well made, and is ornamented. It consits of a cylindrical air chamber with opening in front onto a hearth continuous with the bottom. The circular top has a flat rim with three pot supports, and a fire basin having draught slits as in a grate. Two holes are pierced in the sides of the fire bowl above the fire in front (pl. 17, fig. 2). A pottery three-hole stove with bosses comes from the Philippines (pl. 17, fig. 1).

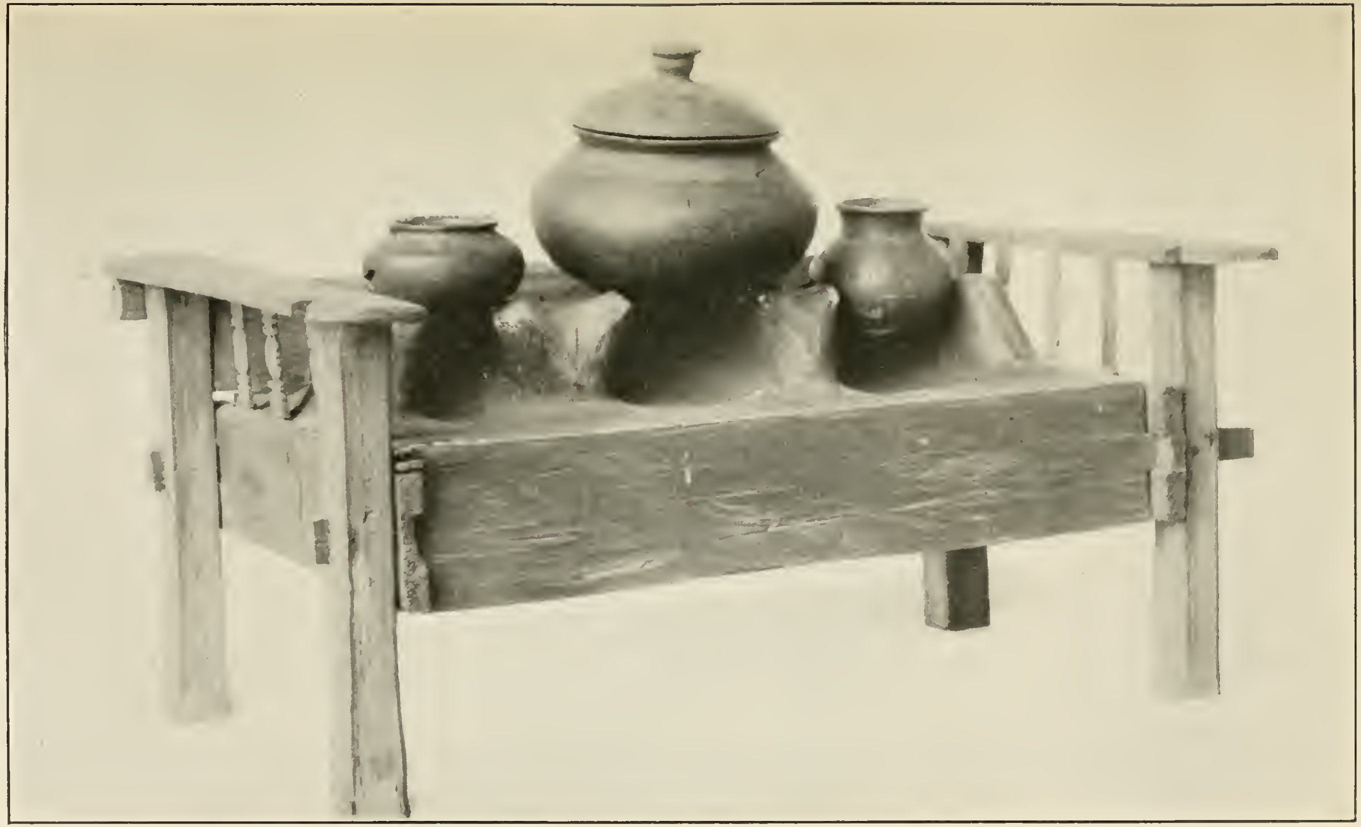
An interesting pottery stove of the upright or Egyptian and Chinese type from S. Christovao, Portugal, was secured from the New Orleans exposition. It is made in a craftsmanlike manner and is of dark gray micaceous resonant ware. The fire box with grate surmounts the cylindrical air box, which has a large oval opening. The cooking pot is a squat vessel with twisted lugs and a lid (pl. 18). In Florence, Italy, there is or was used a tumbler-shaped pottery stove with ledge on the interior on which a grate rests. Such stoves of terra cotta are used for warming portions of the body and for small cooking.[21] Ancient Etruscan stoves of the third century B. C. from Sovana, Italy, are shown in Plate 19.

Metal stoves used extensively among civilized peoples are also sometimes found partaking of a simple character among less advanced peoples. Very simple iron stoves have survived to our day on account of particular employments. Mention is made of a low iron stove from Fez, Morocco. It is a drum shape of sheet and wrought iron, mounted on three legs riveted to the sides and extending upwardly, the ends bent over the fire box forming rests for the pot, that is, serving as primitive andirons. The grate of strips of flat iron is hung midway of the drum. A little hinged door with latch opens on the air chamber. Three holes are pierced through the side of the stove above the grate, an early device for aerating the gases of combustion. The bottom draught is supplied through the little door (20 cm. *d.*, 27 cm. *h.*); collected by Dr. and Mrs. Talcott Williams (pl. 20, fig. 1). From the same country comes a high iron cooking stove also having a drum-shaped body containing grate and air chamber, and the stove is mounted on three legs. There are three air holes above the grate and three hinged supports for the cooking vessel. The stove shows the typical and excellent ornamental ironwork of the north African blacksmith (23 cm. *d.*, 61 cm. *h.*); collected by Dr. and Mrs. Talcott Williams (pl. 20, fig. 2). Even simpler are the small cast-iron stoves formerly used, in 1886 and later, by the Italian chestnut vendors in Washington. These stoves were usually flaring toward the top, were mounted on four legs, and had a grate, hearth, and a bail for carrying. The National Museum has a better stove of this class. The fire bowl with grate is mounted on a base containing the air chamber. There are lugs on the sides of the fire basin for carrying the stove. The maker was Gotscher, and the stove is probably Pennsylvania Dutch cast in Lebanon Valley (pl. 21, fig. 1).

---

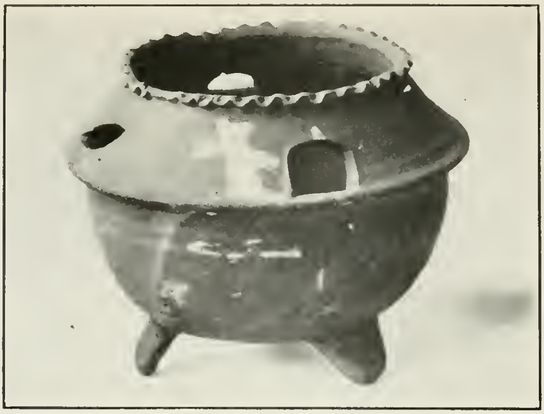
[21] From D. I. Bushnell, Jr.,

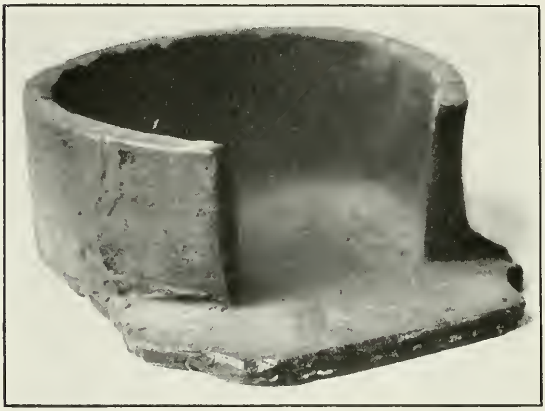
A Korean stove resembles the fire pots of cast iron in every respect. In shape an inverted truncated cone, it has about midway the grate and below a draught-box door and hearth. The rim is cut in a curve for seating the pot. This stove differs widely from the Japanese utensil and is much in advance in respect to draught (pl. 22, fig. 4). Another stove of excellent cast iron is in the Museum. It seems to represent the greatest advance of this type. It has three legs and a hearth. The fire box is shallow and in the bottom fits the grate. Above the fire is an ornamental pierced grating. The margin of the fire box is flaring, is pierced with holes, and has three projections on which to rest the pot. It has a wire bail (pl. 21, fig. 2). There are a number of heating devices which may be classed as stoves. The better-known example of this type is the samovar, "self cooker" of Russia, a device for heating water for drawing tea. It consists of a water reservoir surrounding the fire box of a small charcoal stove provided with grate, air chamber, draught door, and ash box. The reservoir is fitted with a spigot. A small chimney is added on occasion at the top of the heated-air outlet. Usually a teapot for infusing tea leaves is set on this opening. A Chinese water-heating stove in form of a teapot is of this class. It has a circular base of sheet brass, pierced with the mystic diagrams *pa kwa*. In this base a perforated grate rests on three spurs. In the base fits a teapot of pewter, fitted with a hollow cone of brass venting through the teapot lid. Water is confined and heated in the interspace and poured through the spout. The sides of the teapot bear Chinese characters. It is from the Chinese Commission, Philadelphia Centennial, 1876, and is

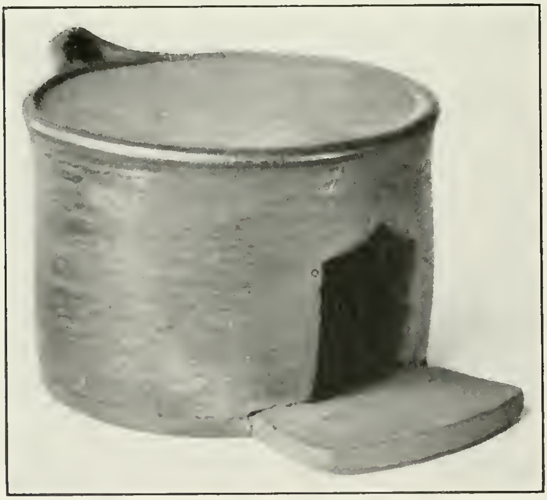


Elaborate Range with Primitive Installation. Philippines

For description of plate see page 47



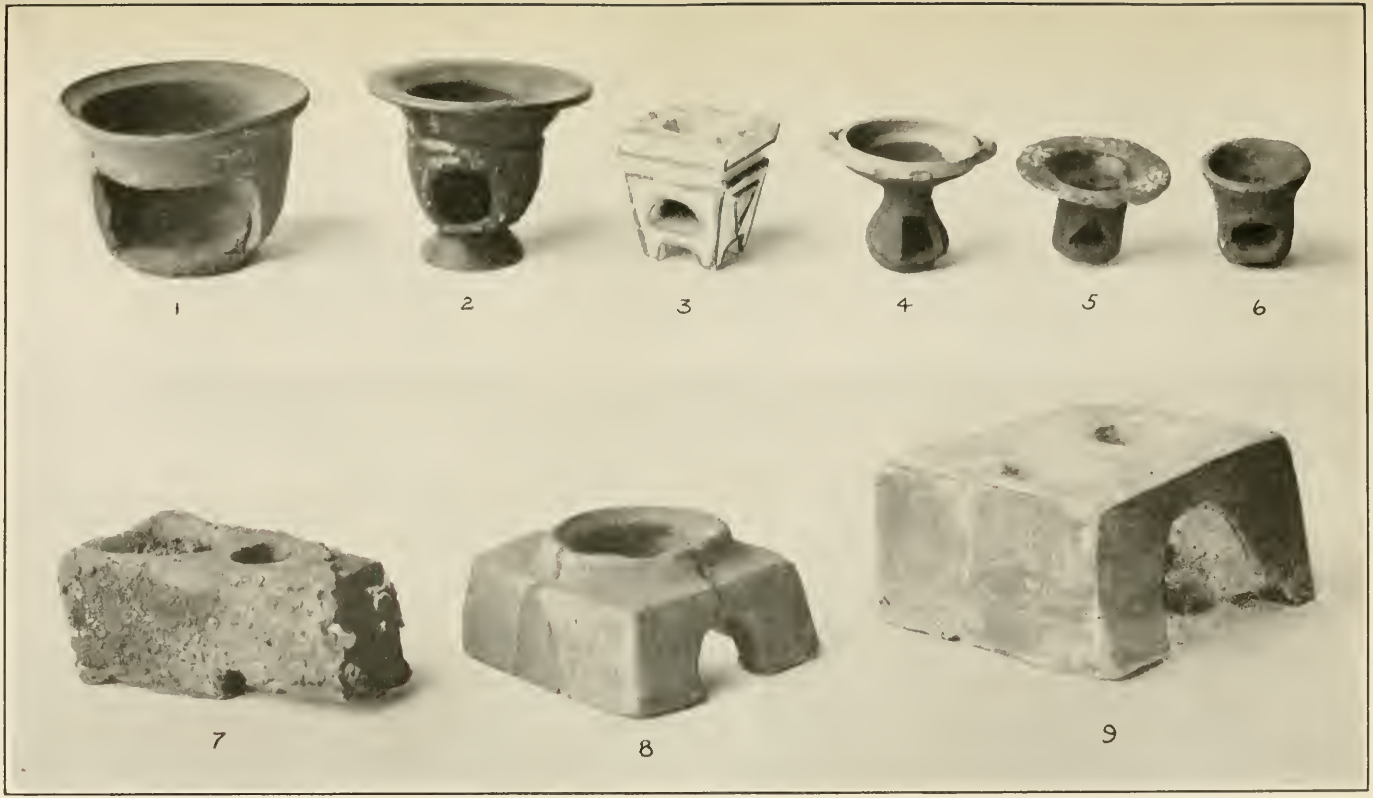




POTTERY STOVES OF SIMPLE TYPE

Top, Bowl stove with suggested draft, Mexico; middle, Pottery stove with encircling wall and hearth, Mexico; and bottom, Inclosed stove with no draft, Mexico

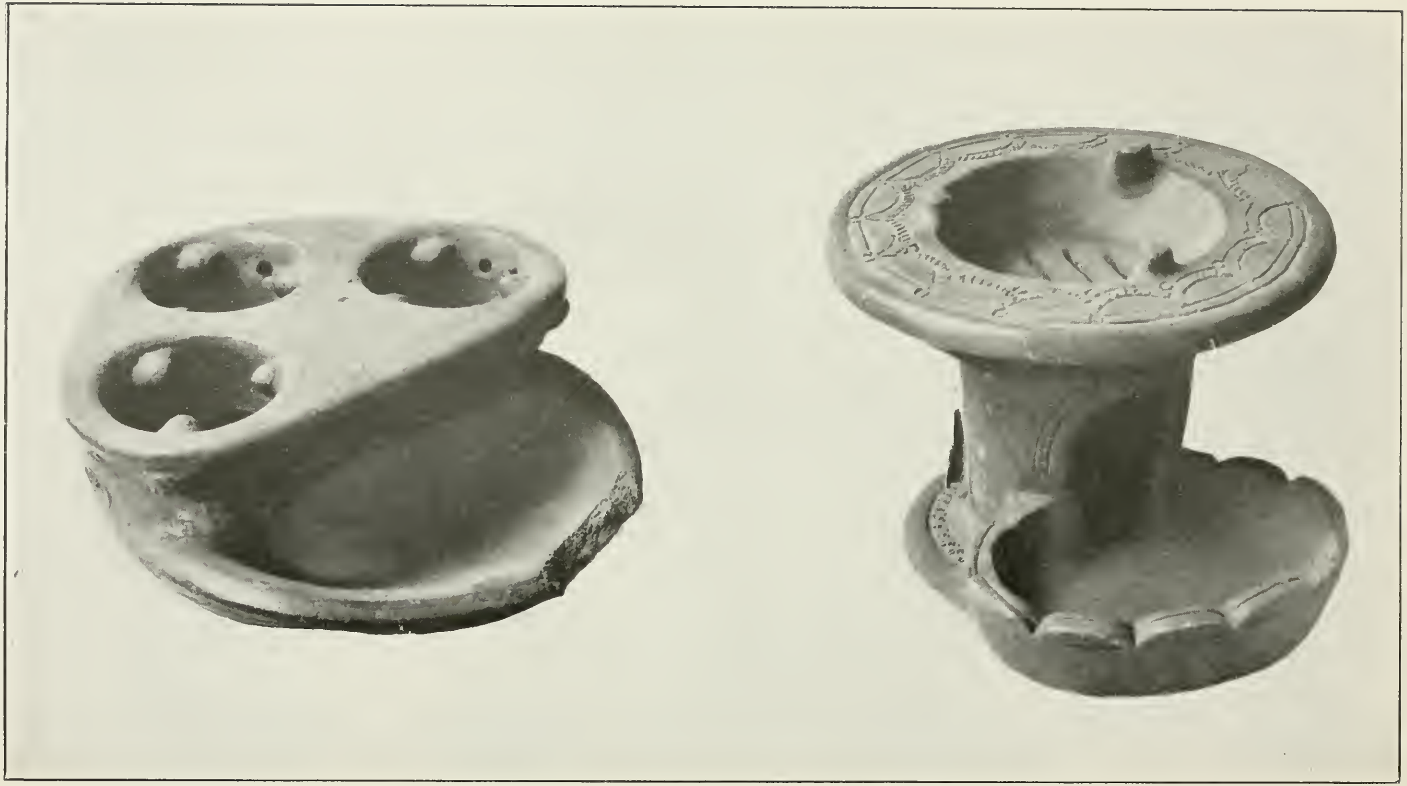
FOR DESCRIPTION OF PLATE SEE PAGE 47



PORTABLE AND FIXED STOVES WITH DRAFT

1, Bowl with side cut out, Java; 2-6, Stove models with grate, Mexico, Spain, Porto Rico, Venezuela; 7, Tibetan stove with flue; 8, Stove from Jogo Kebu, Africa; 9, Stove from Philippines

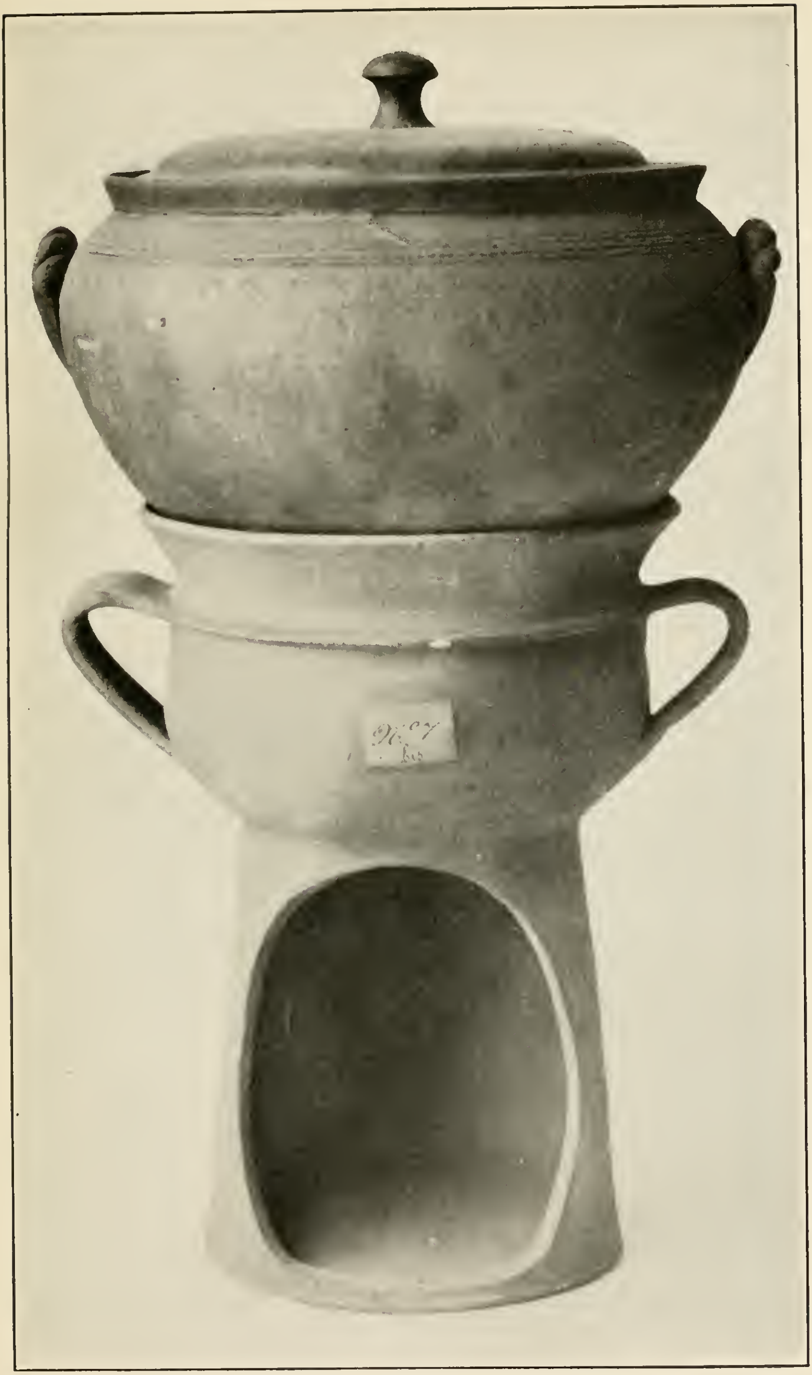
FOR DESCRIPTION OF PLATE SEE PAGE 49



POTTERY STOVES HAVING RUDIMENTARY DRAFT AND WITH GRATE

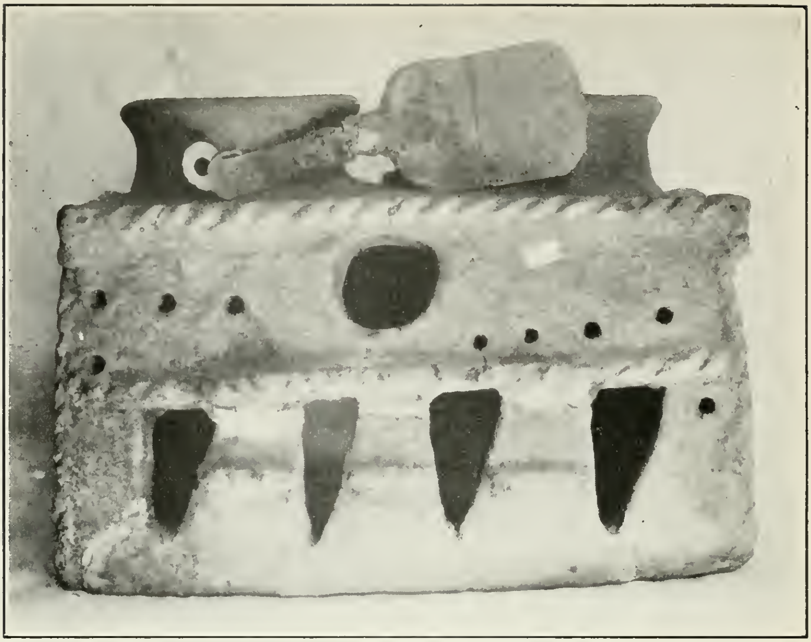
Left, Philippines; and right, Santa Lucia, West Indies

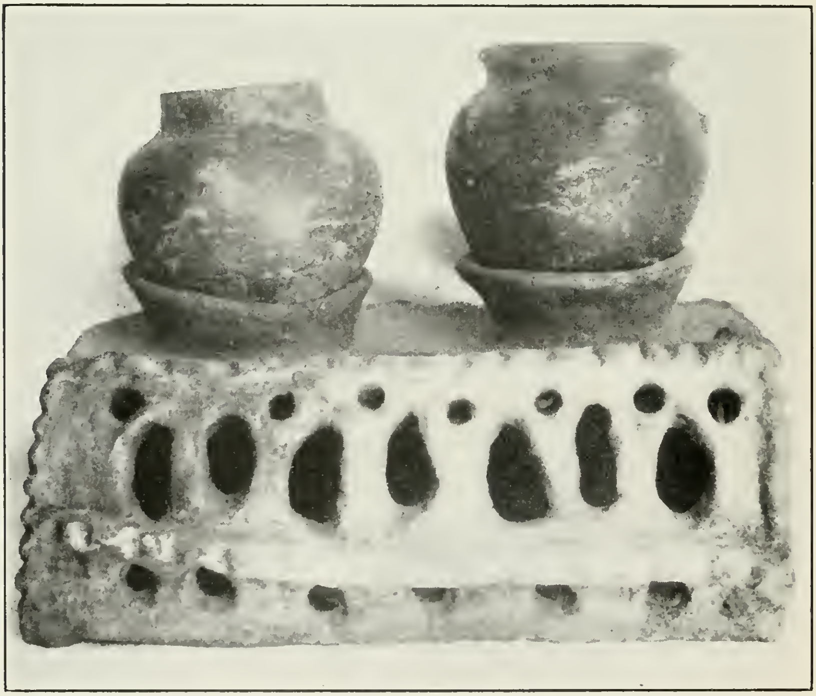
FOR DESCRIPTION OF PLATE SEE PAGE 49



Pottery Stove with Grate, Portugal

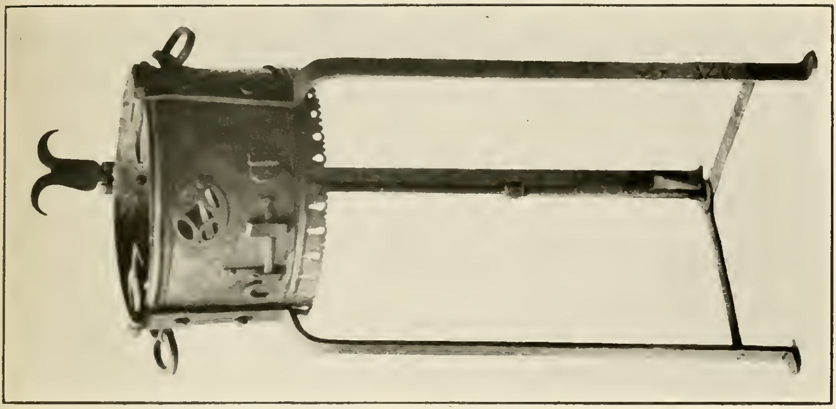
For description of plate see page 49

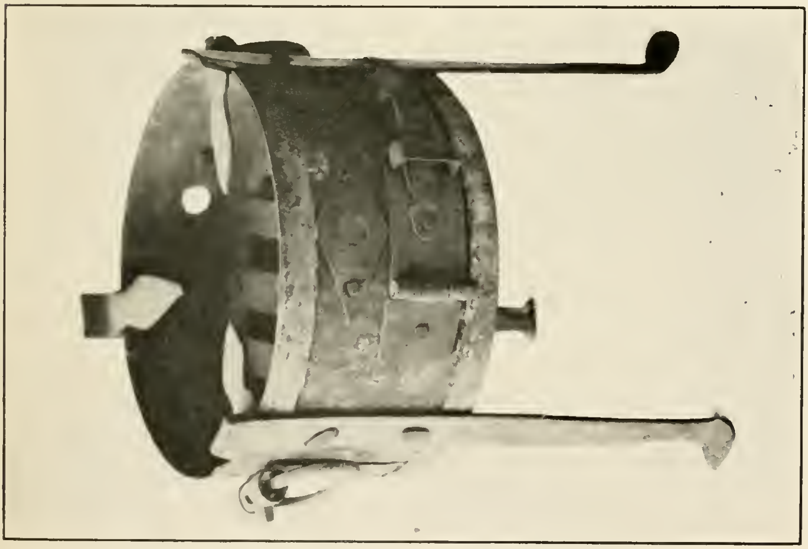




Pottery Arcaded Front Stoves with Pot and Shovel, from Etruscan Site at Sovana, Italy, 3d Century B. C.

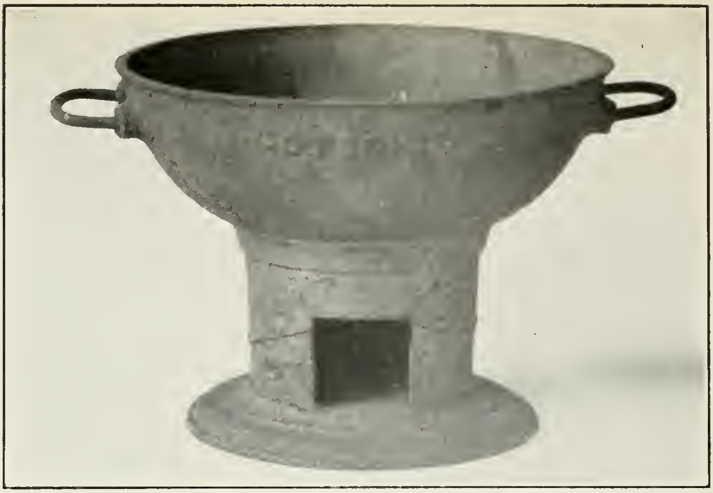
For description of plate see page 52

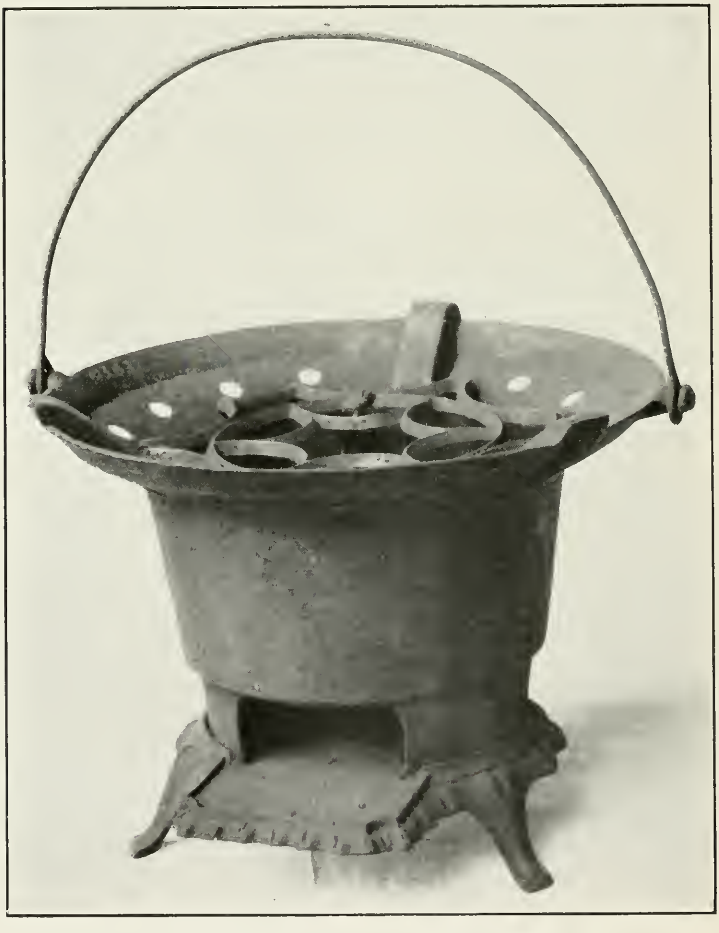




METAL STOVES FROM MOROCCO, AFRICA

FOR DESCRIPTION OF PLATE SEE PAGE 50

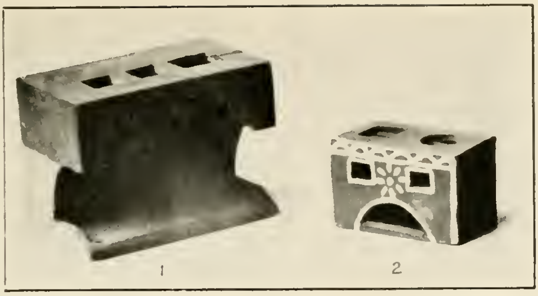


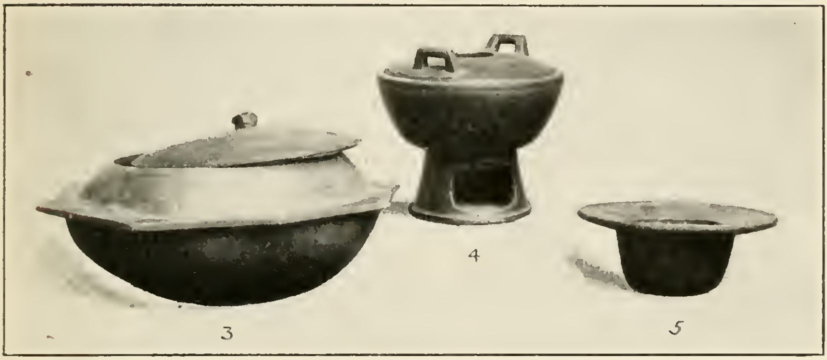


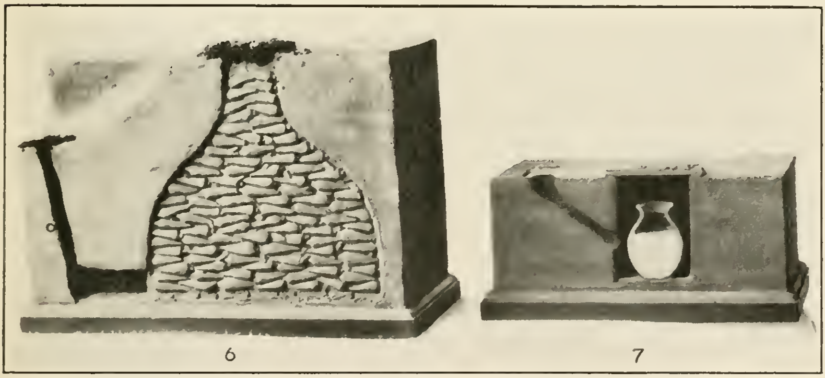
CAST-IRON STOVES WITH GRATE

Top, Pennsylvania; and bottom, San Francisco whaling ships

FOR DESCRIPTION OF PLATE SEE PAGE 50



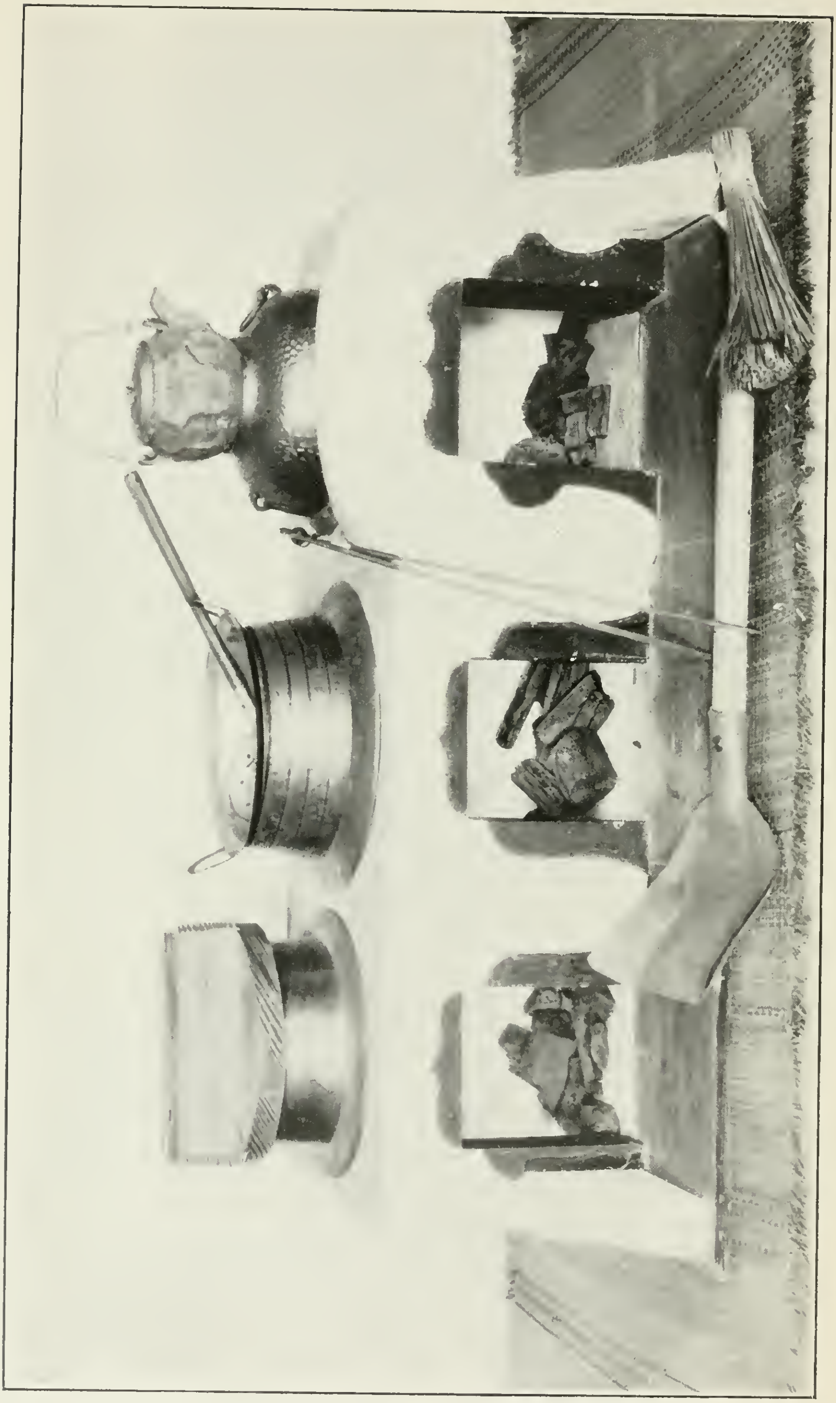




FIXED STOVES, PORTABLE STOVES, AND ABORIGINAL OVENS

1, Three-hole stove with simple draft, Mexico; 2, fixed stove, Mexico; 3, Korean soapstone cooking pot; 4, Korean soapstone stove; 5, Korean cooking bowl; 6, Hopi Indian field oven, Arizona; 7, Hopi Indian mush oven, Arizona

FOR DESCRIPTION OF PLATE SEE PAGES 39 AND 62



Japanese Kitchen Range with Simple Open-door Draft

For description of plate see page 52

10 centimeters diameter and 17 centimeters high. Another specimen from Swatow, China, is of pewter in form of a bowl mounted on a base, with lid. In the center of the bowl is a tubular fire box of brass, with grate above the air chamber and door in the base. The lid has a circular brass-bound orifice fitting tightly over the mouth of the fire box. The lid and vessel have brass drop handles. Food is cooked by being placed in the bowl around the fire box. The Korean cooking stove, *syn syol lo*, is like the Swatow specimen, but is skillfully cut from soapstone. Of this type is a large pewter cooking stove of drum shape from Amoy, China, indicating the fuel economy necessary in that country. The draught door opens on a horizontal brass tube joining the middle of the stove, a vertical tube having a grate at the bottom. This tube is the chimney venting through the top of the stove. The top of the stove has fitted openings for two tubular vessels with lugs and lids and one shaped vessel of larger size. The hollow part of the stove is filled with water, which is heated by the fire in the tube, and the cooking vessels are immersed in the hot water. There is no spigot, as the water is not intended to be drawn off. For compactness, efficiency, and ingenuity this stove ranks very high. It is 33 centimeters diameter and 29 centimeters high, and from the Chinese Commission, Centennial Exhibition, Philadelphia, 1876.

Fixed stoves.—This type indicates a considerable advance in the history of the stove. A number of collateral advances are indicated, as permanent housing, and even the division of the house for varied uses and economics. It marks also a divergence from the camp fire and the portable stoves serving as an early method of assigning fire for special uses. The simpler fixed stoves, however, are on the same plane of invention, having the most rudimentary provisions for draught. The stove of Siam and Laos consists of a wooden frame about 4 feet square and 6 inches high, filled with earth or sand. On this are placed three stones as rests for the pots, and between them the fire is kindled.[22] A Philippine kitchen range is a bench of bamboo with clay seat. On the bench is a row of clay bosses for the installation of three pots (pl. 14). The Philippine earth stove of the Tagals is a platform with door, and having openings in the top for resting the pot (pl. 16, fig. 9). An earth stove from Jogo Kebu, Africa, has a square platform with arched door cut out leading to the fire chambers (pl. 16, fig. 8). There are two holes in the top of the platform of this rude stove. A stove model from Tonalon, Mexico, is rectangular, the base open in front. The upper portion is a box with three square holes on top and three holes in the side for stoking. There is no draught except what may enter at the three doors, and out of the holes when they are not covered with cooking vessels (pl. 22, fig. 1). Another model from Jalapa, Mexico, is a rectangular box with a square and round hole on top over the fire box, in which is a grate. The air chamber has a semilunar opening below and two square openings above, suggesting the ancient sweat-house front. Simple stoves like these, built of stones and mud, are common in Mexico in places where more primitive devices are not used. They also were found in Spain and southern medieval Europe generally (pl. 22, fig. 2).

---

[22] Siam and Laos, Presbyterian Board, Philadelphia, 1884, pp. 175 and 484.

The Mongolian fixed stove is a wedge-shaped construction of earth. The door opening is on one side under the grate. The fire box is a round cavity, from which leads a flue to a fireplace in the wider part of the wedge. The latter is for cooking by parching, roasting, etc., and the former is for placing the vessel for boiling tea. This rude structure shows important features of the developed modern stove (pl. 16, fig. 7). Mr. Rockhill says:

"In the center of the tent of the Tibetans is a long, narrow stove made of mud and stones, with a fireplace at one end and a flue passing along its whole length, so that several pots may be kept boiling at the same time. These stoves, in which only manure is burnt, have sufficient draught to render the use of bellows needless, and are altogether a most ingenious contrivance."[23]

The Japanese kitchen stove is built in three sections, side by side, having each a base, air chamber, and fire box. There are no provisions for draught. The iron kettle has a flaring fin around the middle, so as to give a tight joint when placed over the hole. Heavy wooden lids are used on the kettles (pl. 23). Two similar kettles of soapstone from Korea are evidently for placing on a stove hole (pl. 22, figs. 3, 5).

Ancient kitchen stoves were of the simple character of those described previously. In Florence, Italy, is an ancient stove from Sovana, rectangular in form and with two pot holes, being inventionally merely a box with two holes put over the fire and an improvement on the trivet (pl. 19).

There is an interesting series of developments in the old wide northern fireplace which bear on the lineage of the stove and had a major part in bringing the modern range to its present efficiency. These additions are an oven, a water heater, and an extra small fire in box. The fireplace was thus gradually closed in as cast iron became easily obtainable, and the founder stirred himself to foster and supply demands. The period of the closing in of the fireplace corresponds with the beginnings of great industries, which submerged the house and local industries.

The period of the great house fire and of some of its adaptations mentioned was that in which wood was used as fuel. With the use of coal began a great development, including in its rapid progress in invention the stove, notably that of Benjamin Franklin. With every change also of fuel, modifications took place in the stove and so appeared the gas stove, the alcohol stove, the oil stove, the gasoline stove, and the electric stove. This portion of the history, characterized by a multitude of important inventions, is left to other hands.

---

[23] W. W. Rockhill. The Land of the Lamas, New York, 1891, p. 77.

FUEL

Fuel is particularly a matter of environment, but is chosen for definite purposes of use in cases where the surroundings do not compel the employment of one or a limited number of fuels. There has evidently been comparatively as much research in the kinds and qualities of fuel by man since ancient times as in the inventions for employing fire for a definite purpose. Fuel has reacted on the kind of stove necessary to use it; thus invention is influenced in a manner which seems contrary to the common belief as to the cause of inventions. The fuel question has always since the domestification of fire been a most important problem, vexatious in all ages. The organization to procure and transport fuel has occupied a part of the energies and planning of man time out of mind, and perhaps the first gathering and storing was connected with the fuel for the fire. At this day fuel is the basis of an industry so enormous as to be incomprehensible.

Wood.—The most ancient fuel known to man necessarily was wood, the most abundant and available for the simple fire. It is apparent that this material would be dead and fallen wood, gathered with difficulty and great labor in most situations. It also seems probable that the custom was, as among observed tribes, to use fuel sparingly. An Indian acutely remarked: "White man get lot of wood, make big fire to boil his coffee; Indian use a few little sticks."

As an example of the scientific method of the ancients in regard to wood fuel, Mollett may be quoted under the word Acapna, defined as smokeless: "Wood for fuel, which had undergone several operations to hinder it from smoking when put on the fire. One of the methods employed consisted in stripping the bough of the bark, immersing it in water for some days, and leaving it to dry. In a second method the surface was rubbed with oil, or oil lees, or else the piece of wood was plunged into the oil for a few moments. A third method consisted in slightly charring the surface of the wood by passing it through the flame. The wood prepared by this last process was also called *cocta* and *coctilia*.[24]

The search for something to burn brings out not only examples of ingenuity but throws light on environmental conditions in various regions. Thus we find the inhabitants of Rupchu, Ladakh, and Lahul digging furze roots for fuel in the barren mountains,[25] and the people along the Mexican border digging mesquite roots, which burn very well and make a hot fire. In deforested areas, as in China, the people are forced to use every available material, and grass, bound or twisted up into compact masses for more economic firing, is found to be the most abundant and best substitute for wood. Along the Columbia River the Skilloot fuel was straw, southern wood, and small willows.[26] The Eskimo at Igloolik, where there is no driftwood, used the dwarf willow as fuel.[27] Driftwood of rivers or seashores is a source of fuel. Wood carried into high latitudes by ocean currents and deposited on the shores of Alaska is of great importance in the arts and industries of the Eskimo. During the gold rush the deposits of driftwood were exhausted by miners and the Eskimo seriously inconvenienced.

---

[24] J. W. Mollett. Illustrated Dictionary of Words Used in Art and Archeology, Boston, 1883.

When the Tinne from the MacKenzie River make excursions into Barren Grounds they carry firewood enough to last for the trip. Some of this wood is taken in the form of tent poles, which are used for their normal purpose until the Indians begin the return journey, when the poles supply fuel. The Eskimo will not take advantage of a fire for drying or warming when they have opportunity.[28]

It has happened often in many parts of the world that towns located with regard to accessible wood fuel supply have been forced to remove to another location when the wood was exhausted within carrying distance. Parkman says that villages of the Hurons moved when the ground was exhausted for corn, and firewood distant.[29] A similar state of affairs is noticed among the ancient Pueblos in the Southwest. Modern Pueblos have extended the range of fuel collecting, due to the possession of burden animals. Among a number of the American Indian tribes women were the wood gatherers, and among the Pueblos it was a man's work. Choctaw women perhaps still carry baskets of "lightwood" split, resinous, interior wood of the pine tree, into New Orleans for sale.

Charcoal.—As a by-product of fire, charcoal is always in evidence and its value would be quickly apprehended (p. 22). When charcoal began to be manufactured for a definite purpose is conjectural, but this industry can be safely assigned to the Bronze Age, where its connection with metallurgy is evident. Its use, however, coincides with the employment of the early portable braziers of uncertain date.

Dr. W. Matthews states, regarding the Navaho, that "their manner of preparing charcoal is much more expeditious than that usually employed by our charcoal burners, but more wasteful. * * *

---

[25] Isabella Bird Bishop. Among the Thibetans, p. 137.

[26] Lewis and Clark Expedition, New York, 1893, vol. 3, p. 957.

[27] Parry. Second Voyage, 1824, p. 453.

[28] From E. A. Preble.

[29] Francis Parkman. Jesuits in North America, 1867, p. xxx.

They build a large fire of dry juniper, and when it has ceased to flame and is reduced to a mass of glowing coals, they smother it well with earth and leave it to cool. If the fire is kindled at sunset the charcoal is ready for use the next morning."[30]

The Japanese use several kinds of charcoal, as hard charcoal, "*katadzumi*"; soft charcoal, "*dogama*"; and best charcoal, "*kindzumi*," which is artistically shaped in deference to the conventions of the tea ceremony. They also use branch charcoal, "*yedadzumi*," for artistic effect. The Japanese also prepare balls of powdered charcoal with some binding medium for keeping fire overnight, thus anticipating the briquette.

Previous to the general introduction of coal charcoal was the fuel common to many countries. In the Cuban cities, for instance, "all of the cooking and much of the manufacturing requiring heat are done with charcoal." [31]

Dung.—The diffusion of large ruminants and the domestication of various species have much to do with the fuel problem. In fact, many regions would long have remained uninhabitable or untrackable without this valuable material.

"On the night after the first buffalo scamper we encamped upon a woodless ravine, and were obliged to resort to 'buffalo chips' (dry ordure) for fuel. It is amusing to witness the bustle which generally takes place in collecting this offal. In dry weather it is an excellent substitute for wood, than which it even makes a hotter fire; but when moistened by rain the smouldering pile will smoke for hours before it condescends to burn, if it does at all. The buffalo meat which the hunter roasts or broils upon this fire he accounts more savory than the steaks dressed by the most delicate cooks in civilized life." [32]

This fuel was extensively used by the Plains Indians and other tribes in the buffalo range. The Hopi Pueblo Indians formerly used lignite in burning their pottery; now they use sheep dung made up into convenient cakes. When the pottery is burning two of them control the draft by holding a blanket against the wind in front of the kiln. These animals were introduced subsequent to 1520.

The only domesticated animal in the Americas furnishing fuel is the llama. This fuel is very useful in the upper bolsones or valleys of Peru, and formed one of the chief aids in the movement of population into the treeless Andean highlands.

Nansen says that a kind of guano provided by the gulls is used as fuel by the east coast Eskimos, Greenland.[33]

---

[30] Washington Matthews. 2nd Ann. Report Bur. Amer. Ethnol., 1880–81, p. 175.

[31] E. L. Wakeman. Chicago Inter-Ocean, May 2, 1888.

[32] Josiah Gregg's Commerce of the Prairies, New York 1844, vol. 2, p. 26.

[33] F. Nansen. First Crossing of Greenland, 1890, vol. 2, p. 293.

In Asia the Tartar-Mongols of Siberia, it is recorded in 1253, used ox or horse dung to roast sheep.[34]

Lansdell, decribing the life of the Buriats, gives an excellent summary of the kinds and economic value of animal fuel:

"The collecting, pounding, molding, and drying of dung is, further south, an important branch of commerce. Argols are of four classes. In the first rank are the argols of goats and sheep, which make so fierce a fire that a bar of iron placed therein is soon brought to a white heat. The argols of camels constitute the second class; they burn less easily, and throw out a fine flame, but the heat they give is less intense than that given by the preceding. The third class comprises the argols of the bovine species; these when thoroughly dry burn readily and produce no smoke. Lastly come the argols of horses and other animals, which, not having undergone the process of rumination, present nothing but a mass of straw, more or less triturated. They are soon consumed, but are useful for lighting a fire. This fuel is called 'kiscek' in Russia. * * * It was made from the dung of cattle and sheep laboriously trodden under foot by women, and then sun dried." [35]

George Bogle, speaking of the fuel of western Tibet, writes:

"Here we bathed, and the servants gathering together a parcel of dried cow dung, one of them struck a fire with his tinder box and lighted it.

"The coldness of the climate renders fuel a very essential article, and as no wood is to be had the Tibetans are obliged to use cow dung, which is carefully gathered from the fields. This is built up in a circular form or put into a pot with a hole in the bottom. It makes a cheerful and ardent fire when well kindled, and the people are abundantly skillful in the art of managing it, which my own ill success has often shown me to be a very difficult process."[36]

W. W. Rockhill says: "Yak dung is the principal substance used in domestic architecture among the Drupa Tibetans."[37]

In Persia "the next is the most filthy and degrading work the women have to do; making round cakes of manure, which they slap on every wall for fuel." [38]

Layard speaks of the fire of camel's dung used by the Abou-Salman Arabs at Nimroud.[39]

In Arabia in 1719: "When the caravan halted for the purpose of cooking their breakfast or dinner the dung left by camels of preceding traveling was carefully gathered up, there being no wood;

---

[34] August St. John. Lives of Celebrated Travellers, New York, 1835, vol. 1, p. 23.

[35] Henry Lansdell. Through Siberia, Boston, 1882, p. 368.

[36] Narrative of the Mission of George Bogle to Tibet, 1876, pp. 70, 71.

[37] W. W. Rockhill. Journey Through Mongolia and Tibet, Smithsonian Institution, Washington, 1894, p. 248.

[38] Woman's Work for Women, October, 1888, p. 260.

[39] Austin H. Layard. Popular Account of the Discoveries at Ninevah, New York, 1853, p. 39.

and this when it had been a few days exposed to the sun took fire quickly and burned like charcoal." [40]

An observer in Madeira in 1838 writes that the estiercol of the ass was used for fuel, as the bois de vache of the buffalo in America.

Bones, fish, birds, and fat.—These fuels, while observed in a number of cases, are to be classed as adventitious fuels, or if in customary use, are occasioned by the great abundance of the material to burn. This may have been the case with the Indians inhabiting the shores of the Columbia River from Lewis River to the falls, who were said by Lewis and Clarke, the explorers, to consume as food or fuel all the fish which they take. [41]

The same is no doubt true concerning the burning of the dried bodies of the great auk on the northeast coast of the United States and Canada for fuel. It is known that these now extinct birds were in enormous numbers and easy to catch. E. Charlton states that the dried bodies of the auk were used as fuel on the Westmann Islands.[42]

Bones seem unpromising fuel, but really make a hot and protracted fire, as American frontiersmen know. The Gauchos or cowboys of South America were acquainted with this fact. [43] An ancient reference by Herodotus attributes the custom to the Scythians. [44] In Ezekiel xxiv, 5 and 10, burning bones under a boiling pot is spoken of. The Eskimo are said by Klemm to burn bones rubbed with fat. [45] There is reason to believe that the bones of the giant moa of New Zealand were burnt as fuel.[46]

Extensive use is made by the Eskimo of the blubber of the seal and walrus for cooking food in pots over the lamp. The fat of these animals is best, that of the reindeer containing less oil and producing acrid fumes.

Peat.—This material is of wide distribution, but few references are to be found of its use among uncivilized peoples. It is probable that the need for preparing peat by drying prevented its use. The Eskimo of the east coast of Greenland made some use of peat. [47]

Coal.—The first users of coal were the Pueblo Indians of Arizona. Near the Hopi pueblo of Walpi are abundant traces of burnt coal, and in an ancient village site some miles away the remains of a pottery baking place with layers of cinders and ashes were discovered. [48]

---

[40] Travels of Dr. Thomas Shaw. Lives of Celebrated Travellers, vol. 2, 1835, p. 27.

[41] Lewis and Clark, p. 142.

[42] Trans. Tyneside Naturalist Field Club, vol. 4, 1859, p. 113; reprint in Zoologist, 1860, pp. 6883-6888. Allen, Journ. Amer. Naturalist, vol. 10. January, 1876, p. 48.

[43] Charles Darwin. Journal, London, 1870, p. 194.

[44] Herodotus, vol. 4, p. 61.

[45] G. Klemm. Culturgeschichte, vol. 2, p. 229.

[46] Julius Haas. Moas and Moa Hunters of New Zealand, Philos. Inst. of Canterbury, New Zealand, 1871.

[47] F. Nansen. Across Greenland, vol. 2, 1890, p. 293.

[48] Walter Hough. Museum-Gates Expedition, Rep. U. S. Nat. Mus., 1901.

So far as can be ascertained the Hopi used coal from the near-by veins only for firing pottery. That they secured a high heat is seen by portions of vessels fused in the kiln. This sporadic use of coal is separated by many centuries from the beginning of the employment of this most important fuel by enlightened man.

Fuel oil.—There is no evidence of the burning of natural mineral oils, tars, and waxes in the domestic economy previous to the age of inventive progress. In lighting there is much information that will be considered at another place.

Alcohol, gas, gasoline, and electricity.—Note should be taken of the number and value of modern heating materials over those used before the present age; in fact, none of these deviations produced by science came into prominence until late. Until man is enabled to unlock other forces it may be predicted that gas as a heating product will have the greatest development.

FIRE IN ARCHEOLOGICAL RESEARCH

The value of fire evidences in archeological studies has long been recognized. The tantalizing problem of the beginning of the use of fire is always appended to the discoveries of the skeletal and cultural remains of early man. The fact that clay baked by fire retains imperishably the simulacrum of impressed forms is responsible for information of the greatest value as to the works of prehistoric man. In the ruins in the Pueblo region there are often encountered masses of burnt clay which have impressions of the roof beams, poles, or thatching, giving a clear idea as to these details of architecture. The clay masses are part of the exterior covering of roofs, and record the destruction of a house by fire, in which the clay became baked. Charred corn preserving the size and character of the ears are found, also other objects of wood reduced to imperishable charcoal. It is very apparent also that pottery is one of the best conservers of ancient art. Even the delicate striae of the fingerprints of the ancient artist are preserved.

In classical archeology the value of fire evidences are similarly important. For instance, the "red burnt brick in Egypt is all Roman or Arab; in Greece and Asia Minor, red brick and mortar is Roman, Byzantine, or later."[49]

SMOKE AND FIRE SIGNALS

One of the early uses of fire was in signaling. These were day signals by smoke and night signals by bright fire. Incidently, the odor of smoke became a signal or warning of the presence of man. In the course of development, signals which conveyed a few simple ideas became elaborated and reached in various lines towards radio. People of as low grade as the Tasmanians were very skillful in smoke signaling.[50]

---

[49] How to Observe in Archeology, British Musuem, London, 1920, p. 15.

Xenophon speaks of the signal fires among the Carduchi Kurds.[51] Herrera, speaking of the conquest of Cortez, says that the Mexicans discovered the Spanish army from the top of the hills, and firing the beacons to give the alarm, 100,000 men drew together.[52]

The Apaches of southern Arizona were accustomed to signal at night by setting fire to the stems of large plants. The dry stems burn readily, the flame spreading like a flash.[53] Special day smoke signals are also used by the Apache. A special signal demanded by the law of the Iroquois League was required of a messenger approaching a village at night. He should build a little fire or carry a torch so that there should be no doubt as to his peaceful intent.[54]

While smoke and fire signals were generally used in America and other parts of the world, the Plains Indians had developed an elaborate code by interrupting the smoke column or obscuring the fire at intervals by night. The code has been fully described by Col. Garrick Mallery.[55]

The Eskimo of Kadiak Island have a curious custom. There is a place at each village where visitors stop to signal the village. As they wait they work on an unfinished lamp which is always there and such lamps become the property of the brides of the village.[56]

There has been an astonishing growth in the usefulness of light in the direction of signals, until there is now what may be called a language of light. Most of this growth belongs to the present age, where culminations in technical lines furnish the basis for endless experiment with all classes of mechanisms and materials.

Aside from the tribal fire signals, by which various intelligence was conveyed, the chief use of this method was for lighthouses. These were, in Europe, at first beacons of wood placed on headlands and lighted when shipping was expected. With increased commerce established, beacons were organized in order to give continuous night service. This was difficult with wood and coal employed. The subsequent history of the lighthouse in Europe deals with the application of science to produce finally the great system of marine light signals now in use.

---

[50] H. Ling Roth. Aborigines of Tasmania, Halifax, (England), 1899, p. 84.

[51] Anabassi, book 4, ch. 1, sec. 2.

[52] General History of America, vol. 3, p. 124, London, 1725. He also says that the Otomies used signal fires, vol. 2, p. 253.

[53] Information by Dr. Ales Hrdlicka.

[54] Information by J. N. B. Hewitt.

[55] Sign Language Among the North American Indians, 1st Ann. Rept., Amer. Bur. Ethnol. 1879–80, pp. 536–541.

[56] Information by Miss Alice C. Fletcher.

It is said that the Mexicans had lighthouses on the lake erected on towers and heights. The one on Mount Tocitlan was a wooden structure to hold the flaming beacon.[57]

In the ancient centers of commerce the problems of light signals for mariners was met and famous lighthouses erected at important coast points, as the Pharos of Rhodes, of Alexandria, etc. The Romans built lighthouses around the coasts controlled by them. One of these ancient structures is now within the limits of Dover Castle, England.[58] It is also stated that lightships were used by the ancients.

In the days of the Vikings night beacons, wood fires, were built on hill tops or rocks at times when ships were expected to return. Then came the coal-fire beacon, of which the earliest known is in Sweden and was built in 1202. The coal was burnt in an iron basket hoisted high by means of a long lever. The first continuously tended light in Sweden was in 1635.[59]

The ancient Persians built structures which were called fire towers. One of these, of quadrangular shape and having ramps running diagonally around the four sides to the top, is figured in restoration by Babelon.[60] These towers were connected with fire worship, and may be regarded as high altars. Altars in high places, as have been discovered at Petra and other places in Asia Minor and Syria, were beacons at the time of sacrifices. The same may be said of the fires on the summit of the Mexican teocalis. It is possible that light towers, which have been called lighthouses, have a more particular significance in cult.

Signaling by beacons is of almost world-wide occurrence. Beacons are lighted on special occasions, as the Eve of St. John, or the like, and serve to represent survivals from pagan fire observances. They were lighted in time of war to convey information as to the enemy, or in rejoicings for victory. One of the forerunners of the telegraph relied on fire signals at night. To this day the Weather Bureau uses lanterns for warning of the approach of storms.

The complexity of light signals used by railroads and in maritime commerce is enormous. The utility of glass and the skill in making it in various colors have contributed largely to the variation of light signals.

FIRE HUNTING

Before the finesse of trap or snare hunting appears to have been carried on by stalking and driving, where the quarry was surrounded and driven by bodies of men pursuing methods not greatly in advance of those of the wolves and dogs of Australia. Surprise, stealth, and cunning, as of the animals, the blow with rude weapon, or patient labor to unearth the prey, were the means of early man for taking game.

---

[57] H. H. Bancroft. Native Races, vol. 2, 1875, p. 567.

[58] Harper's Dict. Class. Lit. and Antiq., p. 1225.

[59] Science Service. Science, vol. 58, July 6, 1923, p. vii.

[60] Manual of Oriental Antiquities, London, 1889, p. 173.

Together with this state of rudeness of method was the inexperience of animals, so to express the habits of the denizens of nature now too rarely seen in a state of unfamiliarity with destroying man. It is observed that the beasts have been educated by experience almost more than their pursuers.

Among the rude aids of primative hunters fire became one of the most important. The advancing forest or prairie fire brought out the terrified game better and more quickly than a line of beaters. To this day the Navahos burn over large areas of the forests in the White Mountains of Arizona in their annual hunts. The fascination of fire by night is potent to the destruction of fish, bird, or beast, and thick smoke drives any unwilling animal whatever from his impregnable lair.

At some time animals acquired an instinctive fear of fire. This is shown by the use of hot irons in controlling animals in menageries. In the work of circus men lions and tigers will cringe before a heated poker, and no matter how restless and fretful they may have been, the sight of the glowing iron immediately brings them to their best of animal senses.

A number of methods have been developed, based on a knowledge of the habits and other characteristics of animals. Chief of these are the lures of light, remarked on in another section, and probably later than capture by smoke and heat.

The question of repulsion, especially of insects, by fire agents may be taken up first.

The use of the smudge is almost universal. The Chukchi carry attached to their wrist a small heater (censer) and put in it bits of herbs or dry wood in order to smoke away the insects. The Lapps make a smudge with fungi which grow on trees and which burn slowly and make acrid smoke.[61]

The Tunicas are said to have kindled fires in their palisaded houses only twice a day, presumably to drive out noxious insects; they did their cooking outside in earthen pots.[62]

Gaffarel quaintly says of the Creek Indians that "they are often bothered with little flies, which they call in there language maringous, and it is usually necessary for them to make fires in their houses, absolutely under their beds, in order to be free from these vermin; and they say that they bite severely, and the part of the skin affected by their bite becomes like that of a leper."[63]

---

[61] Cornelius de Paw. Philosophical Researches on the Americans, London, 1791, pp. 1, 247.

[62] J. G. Shea's Early French Voyages on the Mississippi, 1861, pp, 80, 81.

The Indians of French Guiana made a fumigation to drive away snakes by burning cottonseeds over the coals.[64]

A writer in le Congo Illustre figures a company of Niam-Niam or Monbutto harvesting termites by means of fire. At the commencement of the rainy season they eat nothing else. Weeks ahead they pick out the nest on which to operate. They dig at the base of the cone a hole a foot wide and several feet deep. They then make a pile of torches from herbages, and by means of these they overcome the insects, not specially lively at this time.[65]

The Piute of Mono Lake, California, use the larvae of a saturnid moth as food. At certain times the larvae descend from the trees and are caught in a trench in which fire is put.[66]

Regarding stinging ants in Borneo, William Henry Furness says: "Just as we were about to turn in for the night a broad procession of thousands of them, every one with its vicious little tail turned defiantly up, began a diabolical march across our floor of bark. The natives, however, immediately built a small fire directly in their path, which at once caused, first, a stampede of the vanguard, and then all the rest turned tail, and still in quadruple or sextuple file, retreated somewhat more rapidly than they had advanced, and at last all disappeared under the leaves on the ground outside."[67]

The Chinese kill mosquitos with a lamp shaped like a pitcher, having an opening in one side. The insects go in with the draught and are burned on the flame.

The custom of driving game by fire is found in many places all over the world.

In Virginia: "At their huntings in the desert they are commonly two or three hundred together. Having found the Deere, they envison them with many fires and betwixt the fires they place themselves. And some take their stands in the midsts. The Deere being thus feared by the fires, and their voyces, they chase them so long within that circle, that many times they kill 6, 8, 10, or 15 at a hunting."[68]

The Plains Indians accomplished this indirectly, as may be seen from the following quotation:

"Every spring the plains are set on fire and the buffalo are tempted to cross the river in search of the fresh grass which immediately succeeds the burning. On their way they are often isolated on a large cake or mass of ice, which floats down the river. The Indians now select the most favorable point for attack, and as the buffalo approaches dart with astonishing agility across the ice, sometimes pressing lightly on a cake of not more than 2 feet square. The animal can make but little resistance, and the hunter who has given him his death wound paddles his icy boat ashore and secures his prey."[69]

---

[63] J. R. Swanton. Bull. 78, Bur. Amer. Ethnol., 1922, p. 345.

[64] Le Tour du Monde, vol. 40, p. 1021^{e}; vol. 54, p. 76.

[65] Congo Illustre, July 2, 1895, p. 112.

[66] Article by J. M. Aldrich. Journ. New York Entomological Society, vol. 21, March, 1912, p. 1, and information by writer.

[67] The Home Life of Borneo Head Hunters, Philadelphia, 1902, p. 177.

[68] Arber's Capt. John Smith Works, 1608–1631, London, 1884, pp. 365–366.

Baker says that in Central Africa the natives set up nets and start a fire in the grass to the windward in order to catch game.[70]

An ingenious method was practiced in California in which both animals and edible insects were captured.

The grasshopper hunt of the Consumnes Tribes, California, was a great event. A whole settlement would turn out and begin operations by starting a number of small fires, at regular intervals in a circle through the woods, guiding the flame by raking up the pine needles and stamping out the fire when it spread too far. When the fires burnt out there was left a narrow strip of bare ground inclosing a circular area of several acres, within which the game was confined. A large fire was then kindled at a point inside the circle, taking advantage of the direction of the wind, and allowed to spread unchecked. The men, armed with bows and arrows, and accompanied by their dogs, kept to the windward in front of the fire and shot down the rabbits and other small animals as the heat drove them from cover, while the women with their conical baskets on their backs followed up the fire to gather up the grasshoppers which merely had their wings singed, but were not killed. As a squaw picked up a hopper she crushed its head between her thumb and finger to kill it, and then tossed it over her shoulder into the basket.[71]

Some of the minor devices of fire hunting, sometimes involving considerable risk, may be given.

Negroes place a small turtle in a woodchuck's hole, having fastened a cotton wick saturated with oil to its shell at its tail. The turtle runs into the hole, turns around and comes back, and woodchuck is smoked out.[72]

In Afghanistan the hunter with torch goes into the hyena's den throws a felt cloak over animal's head, slips a noose over its forelegs, and drags it out. Arabs use a gag instead of a noose.[73]

In bear hunting the Natchez Indians drop a bundle of lighted reeds in bear hole or shoot an arrow with string attached to point and bearing tinder, the latter dropping down and igniting bear's nest.[74]

---

[69] Elliott Coues. Lewis and Clark. New York, 1893, vol. 1, p. 249.

[70] Sir Samuel Baker. Ismaliia, London, 1874, p. 456.

[71] James Mooney. Amer. Anthrop., July, 1890, p. 200.

[72] Forest and Stream, vol. 5, 1875, p. 183.

[73] Idem, p. 228.

[74] J. R. Swanton. Indians of the Lower Mississippi Valley, Bull. 43, Bur. Amer. Ethnol., 1911, p. 69.

Hunting animals with torches or other lights makes use of the luring or blinding effects of this medium. Its use is extensive in space and time and is employed for the taking of various animals. Among the Haida and other Indians of the coast of British Columbia, birds are taken by torchlight. The Iroquois hunt pigeons in the same way.

Wood, quoting Sproat, says of the Aht:

"'Burning the water' is employed in catching salmon, and is carried on by two natives, one of whom paddles the canoe while the other stands in the bow, where a torch is kept burning, and strikes the fish as they glide through the water"[75] (pl. 24).

The Indians of Cape Flattery hunt seals in this way: Indians, torch in hand, penetrate deep caverns at extreme point of Cape Flattery and kill seals, who are blinded by light.[76]

"Torching" geese is practiced by the Nutka Indians, called Esquates, who live not far from Nutka. "Wild geese * * * caught with nets made from bark, in the fresh waters of that country. Those who take them make choice for that purpose of a dark and rainy night, and with their canoes stuck with lighted torches, proceed with as little noise as possible to the place where the geese are collected, who dazzled by the light, suffer themselves to be approached very near, when the net is thrown over them, and in this manner from 50 to 60, or even more, will sometimes be taken at one cast."[77]

The Chasta Costa (Athapascan), Rogue River, Oregon, fish by torchlight. A torch is placed in the crevice of a rock over the water to attract fish from the deep holes near to the surface within reach of the spearsmen.[78]

On Feather River, California, the Indians fished all night long, having a small fire in the bottom of the canoe built on a layer of earth placed there for the purpose.

The Indians of Puget Sound made use of the torch to catch game—a device entirely unknown among the more northern Indians. They hunted elk and deer at night, attracting them within bowshot by the bright lights. At certain points on the coast, where great flocks of waterfowl flew from point to point, they erected tall poles and on them stretched nets made of cords manufactured from wild hemp and cedar roots. Getting behind these at night they would raise their torches, and it was astonishing to see what numbers of birds would fly against the nets and drop to the ground, stunned by the force of the collision and thus rendered powerless to escape the hunters.[79]

---

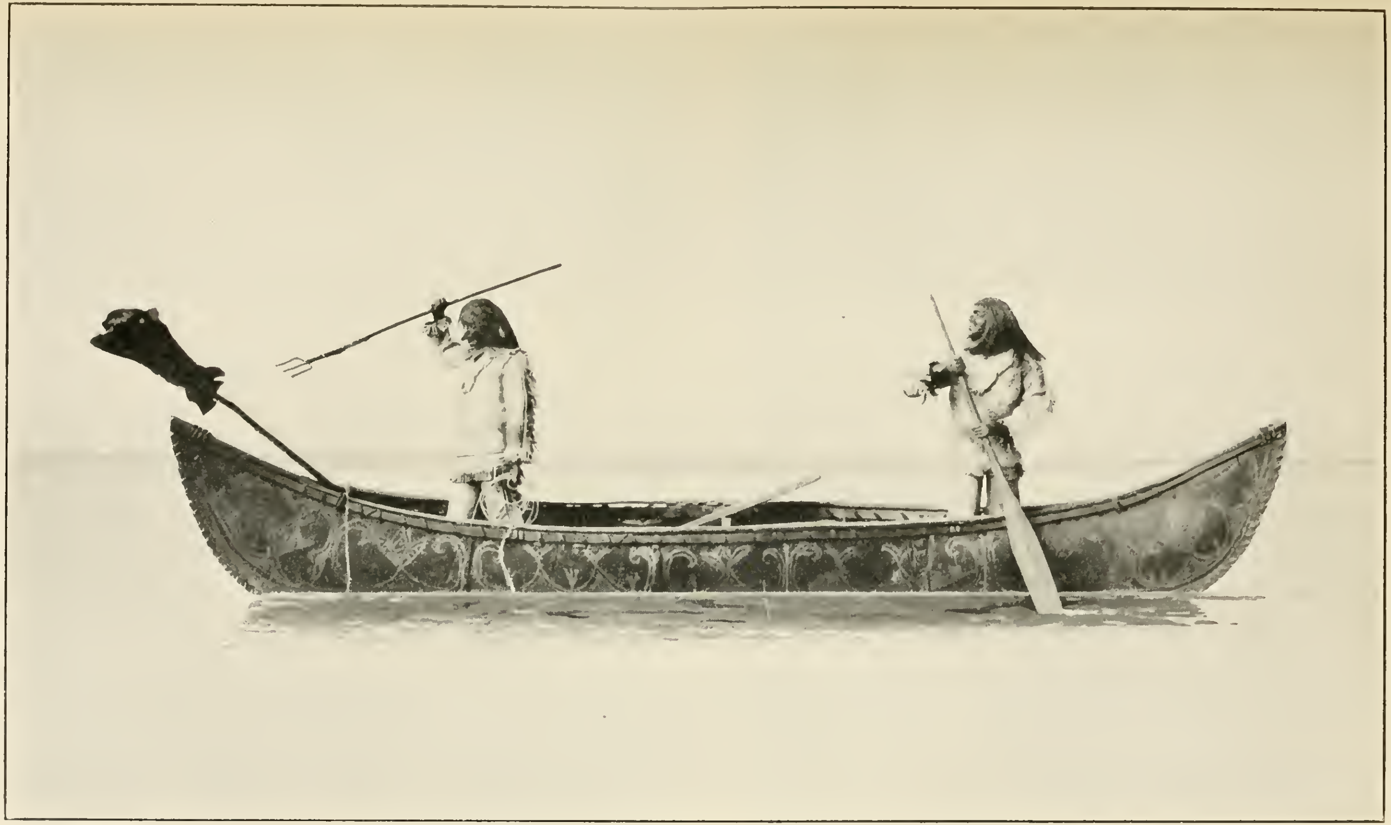
[75] J. G. Wood. Uncivilized Races, Hartford, 1878, vol. 2, p. 729.

[76] James G. Swan. Indians of Cape Flattery, Smithsonian Contributions to Knowledge, No. 220, Washington, 1868, p. 88.

[77] Jewett's Narrative of 1803, New York, 1816 p. 134.

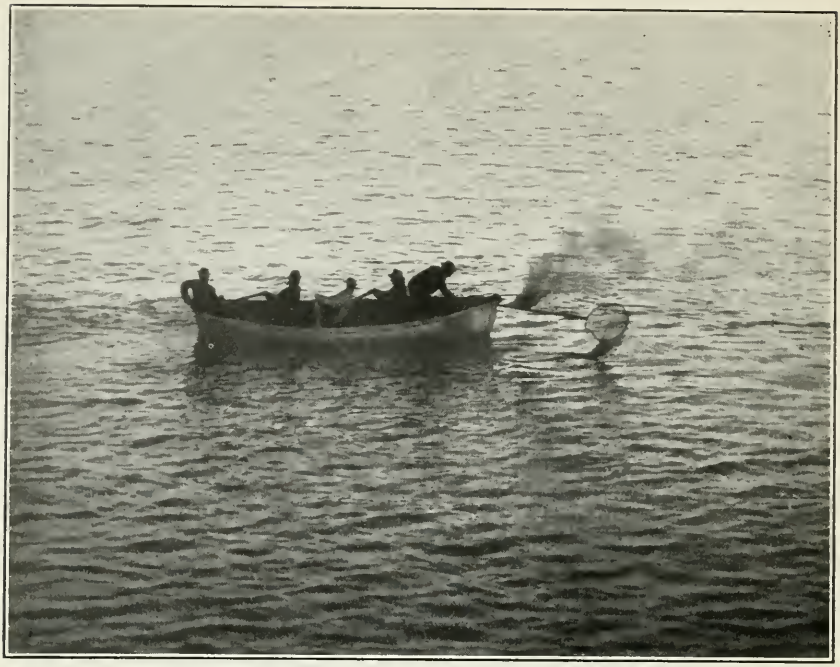
[78] Bull. U. S. Geol. Survey, 1877, vol. 3, p. 30.

[79] Strong. Wah-kee-nah and Her People, New York, 1893, p. 121.

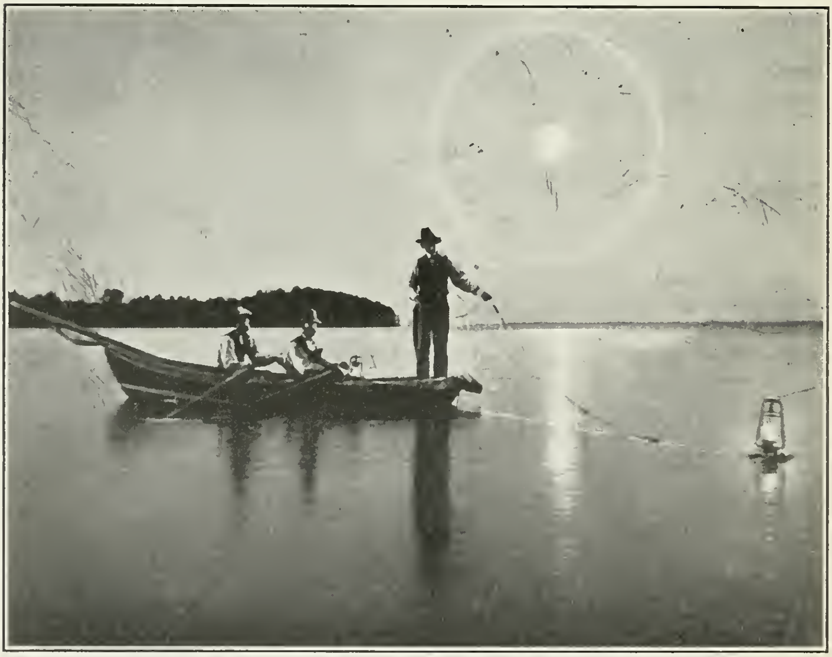


Eastern Indians Spearing Fish by Torchlight (Model)

For description of plate see page 64



FISHING WITH TORCH AND DIP NET, NEW ENGLAND



TORCHING FISH INTO A NET WITH A FLOATING LANTERN, NEW ENGLAND

FOR DESCRIPTION OF PLATE SEE PAGE 65

Beverly decribes fire fishing, commonly called "gigging" in Virginia, where it was practiced up to a few years ago.

"They have also another way of fishing, like those on the Euxine Sea, by the help of a blazing fire by night. They make a hearth in the middle of their canoe, raising it within 2 inches of the edge; upon this they lay their burning lightwood split into small shivers, each splinter whereof will blaze and burn end for end, like a candle. 'Tis one man's work to attend the fire and keep it flaming." [80]

The Senecas used, when deer went into the river to get rid of mosquitos, to come at night in their canoes with a candle of wax at the bow, and the deer seemed blinded. The Indian could go very close to shoot them [81] (pl. 25).

Squier decribes fishing on the Mosquito Coast by torchlight. The torches are made of bundles of fat pine fastened at the top of a long pole. He says that the fish are attracted to the light and are harpooned, the man standing in the bow of the craft. [82]

The Indians of the Antilles also used torches in fishing with dip nets, in the rivers at night.

In Sweden capercailzie were shot by torchlight. [83]

The aborigines of Victoria, Australia, speared fish by torchlight. They carried a bark torch and walked around in the water armed with a spear.[84]

In Burma deer are stalked by light. A lamp is put in a pot with a hole in one side and deer are "jacked" by the light.[85]

CLEARING AND AGRICULTURE

Man and vegetal nature have always been locked in struggle. On the one hand there is subsistence, protection, and a supply for numerous needs, and on the other repression and limitation of effort. If the jungle is accepted we find men living close to nature not many removes from the forest denizens, as the Sakais and Chowpal, "wild men" of the Malay Peninsula. If the jungle is combated, the seeds of progress are sown and man emerges to a better condition. Against vegetation man sets fire and makes an important step in the preagricultural period toward true agriculture. There is seen a period in which man consciously or unconsciously aids the trees on which he depends for food at bearing. Trees approaching the ripening of fruits are carefully watched. There are some references, not to hand, and offered with reserve, concerning the building of fires under bearing trees to ripen the crop. Such a custom was said to obtain in the Philippines in regard to mango trees. The natives of Guam

---

[80] Beverly's History of Virginia, 1855, p. 131. See figure.

[81] Western Reserve Tract, No. 50, p. 106.

[82] E. G. Squier. Mosquito Shore, London, 1887, p. 74.

[83] Forest and stream, vol. 8, 1877, p. 278.

[84] W. T. Hutchinson. Aborigines of Victoria, Chambers Journal, November, 1903, p. 712.

[85] C. P. Wooley. Big Game Shooting, London, 1894, vol. 1, p. 269.

"frequently cut gashes in the trunk (of the mango tree) and build fires beneath the limbs, thinking that the tree will be induced thereby to produce a good crop."[86]

The Panamint Indians (Shoshonean stock) of Inyo County, California, harvest pinyon nuts by means of fire. They pile the cones up in a mound and put brush on the outside and set fire to it. The cones are pitchy and burn freely, and during the process the nuts roast and come out of the cones and fall to the bottom of the pile, where they are gathered. Subsequently they may be better roasted. Circles of stones, which are the fireplaces for this harvesting, are found in the pinyon groves.[87] It will be surmised that these trees are in a sense cultivated through the physical effects on the soil about them of the visitors. In some cases obstructions are cleared away in making a camp, and in other respects the tree is benefited.

In British Central Africa, in the Shire River region, fires are necessary to clear away the bush (grass), which would become an impassable jungle otherwise. These fires, set by the natives, have been observed in parts of Africa from the early ages by travelers. The ground is cleared for garden plots. Frequently the fire jets out and rages over vast tracts of territory.[88]

A similar process is observed among the Cocopa Indians on the Lower Colorado River. An important article of food of these Indians is grass seed. After harvest the Indians burn off the dry grass to clear the land of rubbish, so that when the new grass springs up the harvest may be facilitated. The Indians believe that the grass is benefited by burning, and their idea appears to be good This is a case of unintentional fertilization. It also may be seen that a continuation of this process may work a change in the habits of the grass, leading in some respects to its domestication.

Forest clearing by fire is repeated in many parts of the world. This is a characteristic method of early agriculture of limited extent not furnishing a complete basis of subsistence. An example is seen in the fire clearing for manioc plantation by the Roucouyenne Indians of French Guiana. The natives cut the trees at the approach of the dry season, and later burn them.[89]

The Natchez Indians cut down canes to make a field. When the canes were dry they set fire to them.[90] On this precarious method of Agriculture the Maya cities of Central America flourished. Their decay and changes of base have been attributed to the rapid growth of grass on the cleared ground, preventing work with crude native tools, and the necessity of going farther and farther from the cities to clear lands, and the consequent "human beast of burden" transportation problem.[91] Doctor Cook observes that there is little or no original forest in this region, and open grass lands not reforested prevail as in the prairies (p. 8), giving support to the fire origin of the prairies.

---

[86] W. E. Safford. Useful Plants of Guam, Contr. U. S. Nat. Herb., vol. 9, 1905, p. 315.

[87] Information by Dr. Edwin Kirk. Nov. 18, 1912.

[88] A. Werner. The Natives of British Central Africa, London, 1906, pp. 9–12.

[89] Le Tour du Monde, vol. 40, p. 1021^c, vol. 44, p. 87.

[90] Du Pratz. Histoire de la Louisiane, quoted by J. R. Swanton in Bull. 43, Bur. Amer. Ethnol., p. 75.

There are many curious adaptations of fire in husbandry. In Bhutan the bearded wheat which is grown there is tied up in small sheaves. In some places, as in Kepta, they separate the wheat from the straw by burning it, and in Tassisudon they thresh it out with flails.[92]

More primitive still is the removing of husks from seeds by shaking them in a basket with a hot stone, practiced by the Piute Indians.

TECHNOLOGY

The great subject of aboriginal fire technology can only be treated in a suggestive way by citing a few notes and observations covering the main features. Fire enters into the major and minor arts in some parts of a process, quite useful but often escaping observation. An example is given in weaving, where to render the thread uniform it is singed. Baskets are sometimes finished in the same way.

WOOD

The technology of woodworking by fire has innumerable instances among all peoples. Gross work, such as felling trees, was accomplished by starting a fire at the base of a tree and by alternate burning and scraping away the charcoal until at last it was felled. In some tropical forests there is no dead timber, it being consumed by termites, and it becomes necessary to use live wood. The Southern Indians bruised and frayed the wood with stone axes, thus rendering the burning easier.[93] They laid on clay to guide the fire.

Cutting trees into logs was easily done by fire. The writer remembers that in West Virginia, in clearing when it was desired to cut logs in two, the settlers laid them across and built a fire at the junction. This was called "niggering off" logs. The necessity of large masses of wood would only arise in primitive society, usually for canoes, wooden vessels, log images, etc. Wherever "dugouts" were made they were hollowed out by fire.

The writer remembers very well when a boy seeing a long canoe hollowed out by fire at Morgantown, W. Va. The process took some time, but was cheaper than it could have been done with the poor tools available. The canoe was made out of a long tulip log. It was very cranky on the water, as many a boy found to his sorrow. It finally sank; no doubt it will some day be dug out of the river gravels and preserved as an Indian relic.

---

[91] O. F. Cook. Milpa Agriculture, Smithsonian Report, 1919, p. 307.

[92] George Boyle. Narrative of the Mission of George Boyle to Tibet, 1776, p. 64.

[93] J. R. Swanton. Bull. 43, Bur. Amer. Ethnol., 1911, pp. 66-67.

Not less in skill than any other tribes in the world with regard to the working of great timbers are those tribes living on the northwest coast of America. They not only handle fire for the gross work, but use it as a tool for finishings. They determine the thickness of the skin of the canoe by driving in wooden pegs of the required length from the outside, and burn the wood deep enough to expose the head of the peg.

Marchand says of the Tchinkitanay (Athapascan) of western Canada, that "In constructing a canoe the ancient method of undermining its foot by means of fire is pursued. It is by the assistance of this same agent that they contrive to hollow it out; it is also with this instrument, which is docile in their hands, and the action of which they know how to direct and regulate, that they fashion the tree on the outside so as to give it the form the best calculated for being supported by the water and for dividing the fluid by either of its extremities indifferently * * * fire has the property of hardening the wood to which it has been applied, consequently of procuring it greater density and of rendering it more impervious to water It can not be doubted that they have discovered in fire this property of rendering wood more compact, and of prolonging its duration when it is to be exposed to moisture, since when they make a point to a stake which they intend to be driven into the ground they take great care to harden, by means of fire, all the part that is to be buried."[94]

Jewett says of the Indians of Nutka Sound that they excavate trees by means of chisels and smooth the bottom and sides by burning in order to remove any splinters. This is often repeated as the canoe gets rough.[95]

Turner, referring to the fire-hollowed canoes of New Caledonia, says:

"They had only stone edge tools formerly. They felled their trees by a slow fire close to the ground; took four days to do it. Burned off the branches also, and if for a canoe or house post, the length of log required. If for a canoe they cut a hole in the surface of the log, kindled a small fire, and burned down and along, carefully drop, drop, dropping water all around to confine the fire to a given spot; and in this way they hollowed out their logs for the largest canoes.[96]

The Nutka Indians, Vancouver Island, British Columbia, secured the requisite flare to their canoes excavated from logs by filling them with water and throwing in hot stones, the heat softening the wood and allowing the sides to be stretched and held in place by cross braces. At the same time the sides of the canoe were heated by long strips of burning bark placed at the proper distance.[97]

---

[94] Etienne Marchand's Voyage, London, 1801, vol. 1, p. 348.

[95] Jewett's Narrative of 1803, New York, 1816, p. 71.

[96] George Turner. Samoa, London, 1884, p. 343.

The southern Indians in burning out a wooden mortar regulated the penetration and direction of the fire by means of clay.[98]

Fire was made much use of in bending wood. When a sapling, for instance, is laid aside to dry it is found at a certain stage of the drying if it is forcibly bent it will retain the bend and not spring back. Fire expedites this feature, and also renders it possible to permanently bend seemingly dry wood to the shape required. This is shown in the Sioux method of shaping a bow. By this method the bow, after it is dressed to shape, is bent into a graceful form by rubbing oil on the portion designated and holding over the fire. The wood becomes flexible, and when bent over the knee to shape and held awhile till cool will retain its form. The double curve "cupid's bow" is so bent by the Sioux to favor the bowstring, as the thrust of a straight bow will break the string.[99] The curious twisted pipestems made by the Sioux are examples of excellent bent work. These pipestems, twisted after steeping in boiling water, are held in the crotch of a tree and twisted. They were retained in shape till cold, and would so remain. The Otoe and other Siouan tribes along the Missouri River pursued this method. Ash is the best material for pipestems.[1]

Among the southern Indians the practice was to bend wood with fire.[2]

Another method is by heat and moisture, and still another by steaming. The Mohave Indians of Arizona made excellent fishhooks from cactus spines by bending them with heat and moisture.[3]

Steaming and bending wood was practiced by the Eskimo generally. In the manufacture of bark canoes by the Canadian Indians, David Boyle says:

"The two ends of this bottom strip, having been sharply doubled, are forced between the end stakes, and the united pieces of bark are slightly hollow all along in consequence of this doubling at the ends. A fire having been lighted close by, stones are heated, and these are placed in the hollowed bark, which has meanwhile been filled with water. Very soon the bark has been sufficiently steamed to be forced downward between the stakes to the ground. Strips to form the upper portions of the sides are now added by the stitching method, and by the application of pine pitch to all the joints."[4]

---

[97] Carl W. Mitman. Catalogue of Watercraft Collection, Bull. 127, U. S. Nat. Mus., Washington, p. 221.

[98] J. R. Swanton. Bull. 43, Bur. Amer. Ethnol., 1911, p. 66.

[99] Information by Francis La Flesche.

[1] Idem.

[2] Lawson. History of Georgia, London, 1714, p. 176.

[3] Edward Palmer. American Naturalist, vol. 12, 1878, p. 403. Specimens in the U. S. National Museum.

[4] David Boyle. Amer. Anthrop., new ser., vol. 2, 1900, p. 189.

The use of heat as a means of bending and straightening timber among the aborigines of northwest central Queensland is thus described:

"The aboriginals throughout all the different ethnographical districts both know and practice various methods of bending or straightening timber, either when already cut or in the rough. Thus, a dry heat in ordinary sand, a moist heat from burning freshly gathered gum leaves, or moisture in general, such as soaking in water, is employed for bending any of their wooden implements into shape as required. In order to maintain and preserve the timber in the position attained by one or other of the preceding processes, the whole is covered thickly with grease and fat, saurian or mammalian." [5]

Smoke seasoning of wood is practiced by some African tribes.[6]

Preserving timber by baking was known to the Indians of Nicaragua.

Mention must be made of the universal practice of sharpening and hardening points of wood by fire. It is surmised that the first piercing weapon was made in this way, in fact a development of the fire poker. Implements pointed by this means are found in the débris of the cliff dwellers.

HORN AND IVORY

The shaping of horn by heat is widely known, and probably the art is of great antiquity. The American tribes within the range of horned animals formed spoons and various articles from the material by application of heat. The northwest coast Indians and Eskimo are especially skillful in working horn by heat, and remarkable specimens of this work are in many museums. The Eskimo "soak horn and ivory in hot urine and steam it. This is done before carving. The urine is saved in a kantag and heated with hot stones."[7]

STONE

There is no foundation for the oft-repeated story that stone arrowheads are chipped to shape by fire, as extensive experiments by the writer show. Dry stone of the material from which arrowheads are made will not fracture on the application of water in any degree of heat. In mining, the stone containing the natural "quarry water" is fractured by the expansion action of steam. The removal of stony obstructions in the way of Hannibal's progress over the Alps is probably apocryphal.

In the Philippines the natives soften the (copper) rock by wood fires and then excavate it and extract the ore. The furnaces are holes lined with clay and bamboo blowers supply the draft to their fires.[8]

---

[5] Walter E. Roth. Ethnological Studies Among the North-West-Central Queensland Aborigines, p. 102. Published by Queensland Agent-General's Office, London, 1897.

[6] Sir Harry Johnston. Stanford's Compendium of Africa, 1880, p. 333.

[7] Information by Henry Elliott.

There are references to quarrying by fire in India and other places. There is no authority for the use of fire in aboriginal copper mining in the Lake Superior region, the metal being pounded out of the rock superficially.

"Among the recent discoveries at Hissarlik by Doctor Schliemann are the remains of buildings which he supposes to have been temples. The walls are respectively 1.45 meters and 1.25 meters thick. Nothing, he says, could better prove the great antiquity of the buildings than the fact that they were built of unbaked bricks, and that the walls had been baked *in situ* by huge masses of wood piled up on both sides of each wall and kindled simultaneously. Each of the buildings has a vast vestibulum, and each of the front faces of the lateral walls is provided with six vertical quadrangular beams, which stood on well-polished bases, the lower part of which were preserved, though, of course, in a calcined state. Doctor Schliemann maintains that in these ancient Trojan temples we may see that the *antoe* or *parastades*, which is later Hellenic temples fulfilled only a technical purpose, served as an important element of construction, for they were intended to protect the wall ends and to render them capable of supporting the ponderous weight of the superincumbent crossbeams and the terrace. Similar primitive *antoe* were found in two other edifices, and at the lateral walls of the northwestern gate. It was also discovered that the great wall of the ancient Acropolis had been built of unbaked bricks, and had been baked like the temple walls *in situ*. According to Doctor Schliemann, a similar process of baking entire walls has never yet been discovered, and the *antoe* in the Hellenic temples are nothing else than reminiscences of the wooden *antoe* of old, which were of important constructive use."[9]

In the Salt River Valley, Arizona, the prehistoric inhabitants lined their ditches with clay or puddled earth, which they baked in place with fires of weeds and brush. It is said that these canals retain their lining, and then when cleared out and used by the present inhabitants never foul up with water growth.[10]

This reminds one of the modern practice in some localities of baking "gumbo" for road making.[11]

SMOKE AND ASHES

There is considerable technology of smoke and ashes. The use of smoke in coloring and preserving tawed skins was known to most of the American Indian tribes. The smoke gave the skin a characteristic odor, a pleasing color, and was said to prevent the leather from hardening when drying after being wet. The Indians of the northern woodlands preferred "smoke tanned" leather.

---

[8] Ramon Reyes Lala. The Amer. Mon. Rev. of Rev., Article on Gold in Philippines, p. 76.

[9] Henry Schliemann. Troja, New York, 1884, p. 52. Summary from Scientific American.

[10] F. W. Hodge. Ancient irrigation in Arizona, Amer. Anthrop., vol. 6, July, 1893, p. 325.

[11] Popular Mechanics, vol. 19, April, 1913, p. 567.

The rubber maker of Para uses a smouldering fire, fed with tucuma palm nuts (*Astrocaryum tucuma*), over which he places a clay chimney resembling a bottomless jar or vase with legs beneath. Through this *boias* the thick smoke pours in a constant stream, dries, and blackens the rubber.[12]

Ashes likewise had many uses, the most familiar among the Indians being the removal of the husk of the maize grains. The Pueblo Indians understood the alkaline character of ashes and used it as a detergent. The extraction of alkali from ashes is a very ancient process, and the product was esteemed by the alchemists in prechemical ages.

Rockhill observes that among the T'u-ssu:

"Fire for preparing fertilizer. The people were busy in the field, cutting the sod and piling it in heaps, to which they set fire. When all roots and grass had been consumed, they threw this top dressing of loess and ashes over the soil, which usually received no other fertilizer."[13]

The bone ash of the reindeer was used by the Labrador Eskimo at Fort Chimio as an absorbent of fat from skins in process of tanning.[14]

Lime burning and salt making are widely diffused arts in which fire is employed. Primitive potash and salt industries are described by Dr. Louis Lapicque.[15]

The production of tar and resins must have been exemplified in the fireplaces of early man through the burning of various vegetal materials. No records appear to occur in the Americas of the use of this process, which is analogous to distillation.

The art of distillation must be thought of comparatively late origin and a secret jealously preserved by the alchemists. In Mexico stills having to all appearance a quite primitive character are found in use among several tribes, but the idea is no doubt of Old World origin.[16] Examples of a similar character are found in various parts of the world. Koumiss is distilled by the Kalmucks in a simple still producing a kind of spirits.[17]

MINOR TECHNOLOGY

Among the innumerable uses of fire in a minor way may be mentioned the following:

---

[12] H. H. Smith. Brazil. New York, 1879, p. 85 with figures of rubber maker, gourd jug in wicker, and *boias*.

[13] W. W. Rockhill. Land of the Lamas, New York, 1891, p. 98.

[14] L. M. Turner. 11th Ann. Report, Bur. Amer. Ethnol., 1894, p. 280.

[15] Documents ethnographiques sur l'alimentation mineral. L'Anthropologie, 1896, vol 7, p. 35.

[16] John G. Bourke. Distillation by Early American Indians. Amer. Anthrop., vol. 7, July, 1894, p. 297.

[17] Cyclopædia of Universal Knowledge. Article, Horse.

The Indians of the northwest coast and the Sioux were in the habit of singeing off their hair with a firebrand. Among the Plains tribes the woman cut off her hair and put it in the grave of her dead husband. When her hair grew to its accustomed length she was permitted to marry again.

Du Pratz records that hair was cut among the southern Indians by means of a coal of charcoal.[18]

The western Dene of Canada melted holes through the ice with heated stones previous to fishing in winter.[19]

In pitching their basket water bottles the Ute Indians pursue the following method:

They pound or break up pine pitch, put it inside of the basket, and introduce hot stones which they shake up in the basket, evenly distributing the pitch over the entire inner surface.[20] The Apache also use this method.

A number of tribes parch grain and seeds by shaking them with hot stones in a basket tray.

Major Powell describes roasting seeds in a basket among the Ute Indians as follows:

"They roast them curiously; they put the seeds, with a quantity of red-hot coals, into a willow tray, and, by rapidly and dexterously shaking and tossing them, keep the coals aglow and the seeds and tray from burning. As if by magic, so skilled are the crones in this work, they roll the seeds to one side of the tray as they are roasted, and the coals to the other."[21] The southern Indians parch maize in this manner.[22]

The extended use of heated stones in cooking is taken up on page 40.

DECORATION

Decorative art is indebted to fire in many applications to wood, leather, horn, bone, bamboo, and other materials. The use of fire for such purposes is still current under pyrolizing or "poker work." The American Indians employed it on small surfaces, as pipestems, clubs, tomahawk handles, and so forth. One of the first uses of files brought by the trader was to heat them and press them on wood surfaces, producing a grained effect pleasing to the Indians. A variety of this ornamentation, practiced by the Chippewa and a few other tribes, consisted in winding a strip of skin around a cylindrical piece of wood, as a lance shaft, and holding the object over the fire till the exposed spaces were deeply smoked.

---

[18] Du Pratz. Paris, 1758, vol. 2, p. 198.

[19] A. G. Morice. Proc. Canad. Inst., vol. 25, October, 1889, p. 130.

[20] Information by Judge Nathan Bijur, New York.

[21] J. W. Powell. Exploration of the Colorado River of the West, Washington, 1875, p. 127.

[22] J. R. Swanton. Bull. 43, Bur. Amer. Ethnol., 1911, p. 74.

METALLURGY

In an article printed in the Proceedings of the National Academy of Sciences there was presented a paper giving the results of a research into the development of metallurgy.[23] In this article it is shown that the progress of metallurgy up to this age of great progress was dependent on the increase of heat by various devices. By this man was gradually able to work the great pentad of metals familiar to him in nature, namely, copper, tin, gold, silver, and iron, forming the substantial basis upon which modern metallurgy rests.

Modern metallurgy is truly a wonder-worker. With the combination of engineering, chemistry, and physics man has freed elements which have never before appeared in the metallic state.

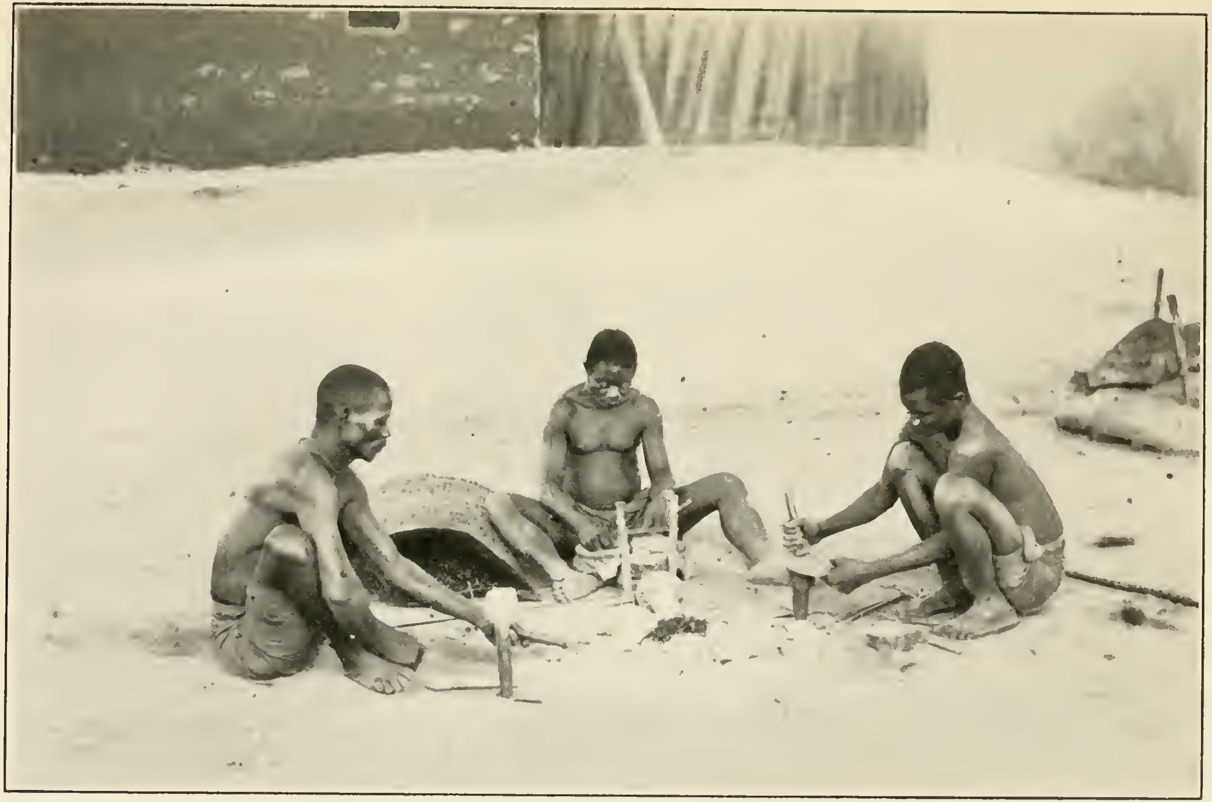
Necessarily metallurgy appears at a comparatively late date in the history of man's acquaintance with fire. Its rudiments are, however, in the fireplace of early man. The gentle draught of air or the more active breeze freshens up his fire, and this may be accomplished in still air with a broad leaf or a manufactured fan. Farther on it is found that by blowing through a tube made of one of the grasses a more direct and intense blast of air can be produced. The tube is to become the tuyere and the fan the blast driver, combined in the bellows and culminating in the vast apparatus for forced preheated draft in the modern colossi of the metal industry.

Because of the specialization of the industry and its multifarious demands, as sources of metals, ores, and fuel, transportation and commerce, together with inventions and skilled workers, there arose centers or foci renowned in the ancient world for metal working. To a certain degree this was preceded by a period of discrete or household industry observed generally in Africa.

The niceties of the reduction of ores remained for modern science, early metal workers confining their attention to varieties which could be reduced by the facilities and knowledge in their possession. It is possible that the Bronze Age even at its focus may have overlapped the Iron Age, and it is not strange that some students should have been led to assert that iron preceded bronze. The accumulated knowledge required for the reduction of an inconspicuous ore to secure a metal not known in a free state and with properties and value unknown is greater than the production of an alloy of two metals, one free and the other practically free, and both known to man for untold generations. There are also the high temperature, 1,200° to 1,300° C., and the experimental data on fluxes required in the reduction of iron ore. The metallurgy of iron was a distinct advance on that of bronze and made use of the experimental knowledge and mechanical equipment acquired in the Bronze Age. The

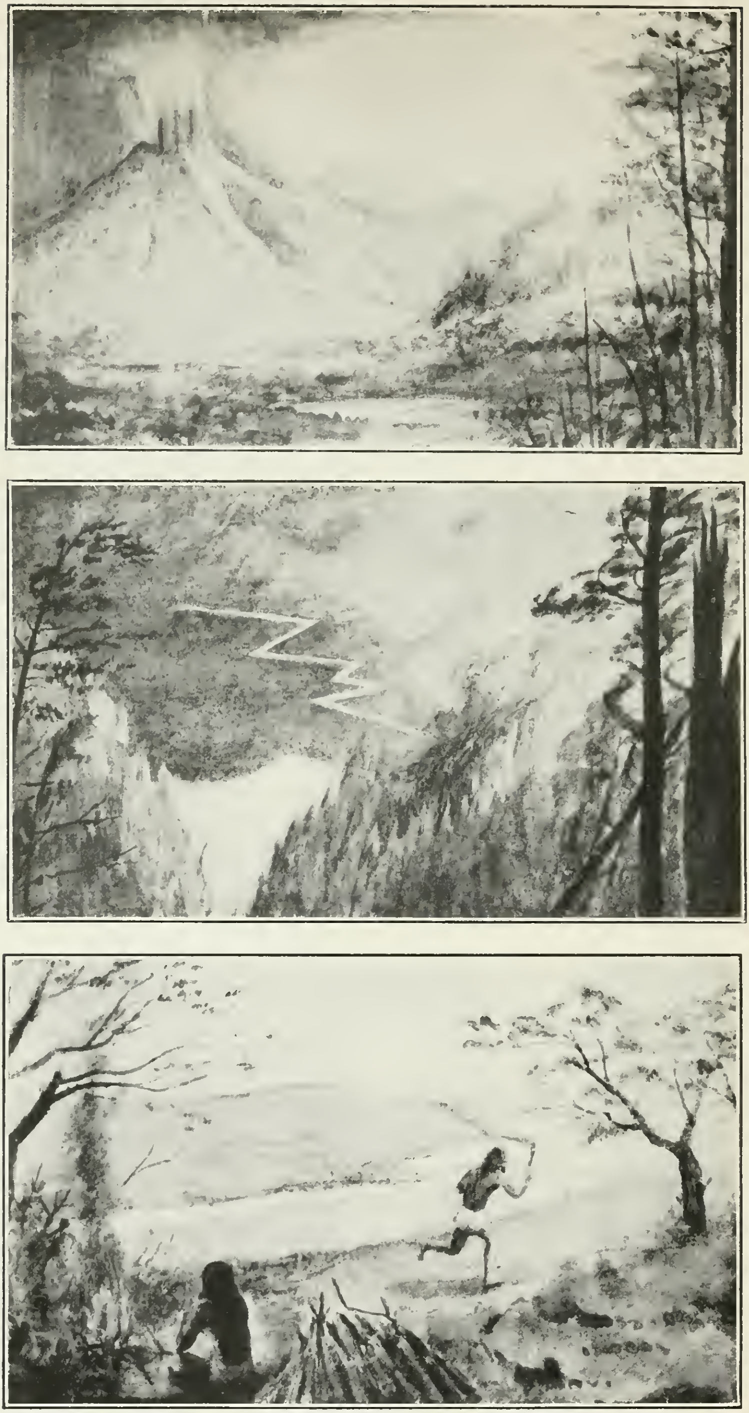
---

[23] Walter Hough. Man and Metals, Proc. Nat. Acad. Sci., vol. 2, March, 1916, p. 123.



Angola Native Blacksmith at Work, Using a Two-phase Bellows

For description of plate see page 75



SOURCES OF FIRE IN NATURE AND PRIMITIVE CAMP FIRE

FOR DESCRIPTION OF PLATE SEE PAGE 84

bellows, which classical writers attribute to Daedalus and Anacharsis, may have made possible the reduction of copper ores in the later Bronze Age, and may have unlocked at another period the coming metal, iron.[24]

The critical invention in metallurgy is the bellows (pl. 26), which belongs exclusively to the Eastern Hemisphere, the western world having only advanced as far as the blast of human breath through tubes. In this respect it may be said that the metallurgy of America is more primitive than any reported in the Eastern Hemisphere. The ridiculous blast furnaces of ancient Peru described by Garcilasso, in which a circle of men blew through tubes into a central crucible, is an example.[25] It appears that this method was employed in the higher civilizations of America. Outside of these areas it is not probable that any metal was worked by heat.

Primitive metallurgy has attracted several students. The research of R. Andree may be cited in going farther into the subject.[26]

The manufacture of bronze, which ushers in the new era, is so complex that it must take place late in the history of metallurgy, which itself begins long after man has become acquainted with some of the free metals, especially copper, which was worked cold or with a modicum of heat in America and elsewhere. A period, much limited in extent, when copper was pounded, seems to have preceeded the working of bronze, but copper is difficult to melt and cast, and it is probable that bronze resulted from experiments with mixtures to lower the melting point and to admit of casting in a closed mold. Metallurgy, considered from the standpoint of the utilization of fire probably follows the intensifying of heat for certain purposes, as the heating of a pit oven for the roasting of roots (the pit furnace was a device of ancient bronze workers), or in the various kilns by which fire was confined for burning pottery. Thus, a heat has been observed in the ancient potter's kiln discovered in Arizona which sometimes fused and distorted the clay and produced vitreous slag.[27]

The discovery and use of fluxes must be considered.

As mentioned in the article quoted, "the metallurgy of iron was a distinct advance on that of bronze and made use of the experimental knowledge and mechanical equipment acquired in the Bronze Age.[28]

CERAMICS

It is obvious that the ceramic art long antedated metallurgy. The Bronze Age appeared as an inclusion in the later Neolithic, while the earliest pottery is found in the beginning of the Neolithic.

---

[24] Proc. Nat. Acad. Sci., vol. 2, 1916, p. 126.

[25] John Fiske. The Discovery of America, vol. 2, 1892, p. 360.

[26] Die Metalle bei den naturvolkern mit berucksichtigung prahistorischer verhaltnisse, Lepzig, 1884.

[27] Walter Hough. Archeological Field Work in Northeastern Arizona, Ann. Rept., U. S. Nat. Mus., 1901, p. 334.

[28] Proc. Nat. Acad. Sci., vol. 2, 1916, pp. 126–127.

Pottery furnishes its own enduring record, and it was, before the modern discoveries of antiquity, probably known to Sir Thomas Browne that shards were quite as imperishable as charcoal.[29]

Clay heated to 750° F. has driven out of it the water of combination and becomes incapable of softening by water This observation is unexcelled as to antiquity, and due to be made at one time or another by the earliest users of fire. Nevertheless, it was an immensely long period before this knowledge had practical adaptation in the formation of vessels or other objects of use.

The presumed order of development is: Observation of the effects of heat on the fireplace or surroundings, as clay margins, etc.; hardening of perhaps children's artifacts thrown in the fire; when fire accidently or otherwise preserved the shape of clay-covered structures of vegetal elements, as primitive daubed houses or vessels such as the Mohave Indians of Arizona make, only suggestive; and the actual making and firing for a definite purpose, the so-called discovery. The wheel follows, beginning with rudimentary devices for handling the ware, and arrives at an effective machine. Gradually also there is an increasing command of heat, and with selection of clays stoneware is made, and so on through the history of ceramics.[30]

GLASS

The history of glass making in respect to its bearing on the progress of our knowledge of nature covers a very interesting field. Glass is one of the results of unconscious experiments, primarily giving rise to the observation of the effects of fire on various materials happening to be subject to its action. These observations could occur innumerable times in early periods before the next step toward the utilization of the fused product could be taken. The advance is made when the cultural stage demands it. Glass is foreshadowed in the reduction of ores. Thus the manufacture of glass is recent when compared with the time column. Popular belief in the discovery of glass by the fortuitous presence of sand and niter in a beach fire is led astray by fables invented to fit imaginary happenings. Long before the discovery of glass the metallurgist was familiar with slag, and the potter in an unusually hot fire sometimes produced the forerunner of glaze. Lava also was a practical demonstration of the solvent power of fire well within the experiences of some of the groups of primitive man.

BATHS

There is little data on the origin of the hot-air and vapor bath, though there are many references giving the custom great antiquity among civilized peoples.[31] The distribution of the custom over wide areas, also, gives evidence that this feature of the use of fire was known in very early times. The method may be of extreme simplicity or as complex as the Roman thermae or our modern Turkish bath, attended with every luxury.

---

[29] Sir Thomas Browne. Hydriotaphia. Works, p. 377.

[30] See Synoptic Series. Proc. U. S. Nat. Mus., vol. 60, 1922, p. 40.

[31] Strabo. Book 3, chap. 3, par. 7, says that heated stones were used for the hot-air bath by the Lusitanians and Lacedemonians.

The American Indians pretty generally employed the vapor and hot-air bath. The vapor bath was most common, the hot-air bath being employed by the Eskimo and in California by all the tribes except those in the extreme northeast. The sweat lodge or house was constructed with great care and with religious observances. Sometimes they were of flimsy construction of slender poles covered with skins or blankets, or regular structures covered with sod or earth. Often they were large and formed a meeting place, as the Pueblo kiva. The kiva however, named by the Spanish estufa under a misapprehension of its character, was not used for the vapor bath. The same may be true for other lodges devoted to social and religious life by some tribes.

The Pueblos in general did not use the vapor bath, but in some cases may have employed the hot-air bath. The method of supplying the vapor was the same in all cases. Stones were heated in a fire and removed with sticks or tongs (see handling) to a small pit inside the entrance of the sweat house. Water was poured on the stones and the orifice or door closed. Generally more than one person occupied the sweat house. After the sweat bath, if a stream were available a plunge was taken.

A form of sweat bath in which the patient is covered with heated earth is mentioned by Charlevoix.

The temezcal or vapor bath of the Mexicans was apparently more scientifically constructed than those of any other peoples of the New World. As pictured in the codices and described by the earlier writers on Mexico the temezcal was a rectangular structure of stone having a low door with ventilating apertures placed on either side of it. Built against one end was a rounded oven having a smoke hole in the apex, a fire door and a flue leading into the adjoining chamber.

The temezcal was dedicated to a divinity and the curative effects of the bath ascribed to supernatural powers. Various infirmities were treated. The bath was public and free, those using it bringing some small offering of wood or pulque. Under Spanish influence temezcals assumed a beehive shape, but examples of the ancient type are still found in use, notably at San Juan del Pyramids.[32]

The southern Alaskan Eskimo, in common with the Indians, make use of the sweating bath, the large conical houses commonly serving for the purpose. It is not known how far beyond the shores of Bering Strait this custom extends, but it ceases before the snow house begins.[33]

---

[32] The above data was secured from an excellent article by Jose Maria Arreola, published in Ethnos, vol. 1, No. 1, Mexico, 1920, p. 28.

The sweat houses or sweating booths of the Shuswaps are identical with those of the Tinneh, Crees, and other peoples. They consist usually of about a dozen thin willow wands planted in the ground at both ends. Half of them run at right angles to the other half, and they are tied together at each intersection. Over these a blanket or skin is usually spread, but I have also seen them covered with earth. A small heap of hot stones is piled in the center, and upon these, after carefully closing the apertures, the occupant pours some water. The sweat house is always situated on the banks of a stream or lake, so that on issuing therefrom the bather may at once plunge into the cold water.[34]

The Kiowa (Kiowan) sweat lodge is a half oval crate covered with skins or blankets. Two poles are stuck in the ground at each end, bent over until the four meet in the middle of the roof. Across these are horseshoe-shaped bows at intervals of a foot stuck in the ground to form the crate. Robes are laid over these to make all steam-tight. A slight excavation in the middle of the floor receives the stones, heated in a fire outside. Water is poured on the stones, the naked bather lies on his mat inside, and afterwards plunges into the water.

Special vapor baths were given, an example of which may be cited among the Coucouyenne Indians of French Guiana, where a woman after birth of an infant is given a vapor bath by placing hot stones under her hammock and throwing water upon them.[35]

For comparison the Russian bathhouse has a stove in the center and benches one above another like those of a greenhouse. Large stones are heated in the stove; when they are taken out water is poured over them, filling the room with steam. The people lie on the benches, and the hottest part of the room is on the higher benches.[36]

Several reasons are given for the use of the vapor bath; as a sanitary practice, for the curing of disease, and as a religious observance. All these classes are found in America and in other places where the sweat bath is distributed.[37]

One of the earliest observations of men acquainted with fire would be the effect of water on live coals, producing steam. The utilization of steam for the purposes described is an interesting feature of the fire study, presenting as it does one of the earliest employments of water vapor.

---

[33] Dr. H. Rink. The Eskimo Tribes, Copenhagen and London, 1891, p. 12.

[34] G. M. Dawson. Trans. Roy. Soc. Canada, sec. 2, 1891, pp. 7 and 8.

[35] Le Tour du Monde, vol. 40, p. 1022c; vol. 54, p. 96.

[36] Through Iceland, Holland, etc., 1893 (Murray's Handbook) p. 135.

[37] See Article, Sweating and Sweat Houses in Bull. 30, Bur. Amer. Ethnol.. 1910.

SANITATION

There are a few recorded instances where fire or one of the products of fire, as smoke, was definitely employed as a sanitary agent. Smoke as a preservative of food and in various other technological uses was perhaps early known. These features will be treated in another place. As an instance of sanitation among the ancients, it is observed that Ulysses after the punishment of Melanthesis and the slaying of the suitors had his house purified by burning sulphur.[38]

Bundles of willow twigs were kept by the Point Barrow Eskimo to be burnt one at a time to destroy bad odors.[39]

While smoke may appear to be merely a means of disguising odors, or even for the production of sweet odors, as Shakespeare says, "and burn sweet herbs to make the chamber sweet," it undoubtedly exercises a minor germicidal action from its constituents.

The fondness of orientals for smoke scents is well known. In Japan especially the use of resins and gums worked into decorative forms has risen to a high expression of art. Among the Romans this luxury was carried to the extreme of perfuming the oil for lamps. Incense grows out of these uses, fostered by beliefs in the efficacy of this product of fire.

HEALING

In prescientific medicine the application of heat for healing was common and widespread. There is also information of very ancient practices of this character. Crania from the Neolithic stations of Feigneux, Conflans-Ste.-Honorine, Vaureal, Menonville, have been found bearing cauterizations which L. Manouvrier relates to the classic and mediæval practices for the treatment of melancholia and epilepsy.[40]

The usefulness of heat application is a matter of experience, and is prevalent in folk and even scientific medicine to-day. Most of the practices are mixed with superstition, in which no doubt the ancient veneration of the mystery of fire has a prominent part. The Thonga of Portuguese South Africa illustrate a widespread custom in Africa and appearing elsewhere.

"A third practice, quite as old as the foregoing, is the tlhema or cautery. This may be done with a packet of roots which are heated and applied to the part affected. But, as a general rule, cautery is done with the foot. This is, undoubtedly, a curious proceeding. Kokolo gave me a detailed description of it: A hoe is made red-hot, an obliging individual lends his foot, a foot which has rarely been incased in a shoe and possesses a sole with a skin like leather. This natural sole is rubbed with the leaves of a plant called shungwe, which has been chewed and mixed in the palm of the hand with saliva and grease. For the same purpose Mankhelu employed a fat comprising, among other ingredients, the following drugs: Hlampfura and Nwambula-wamitwa. Then the kindly operator places his foot on the red-hot hoe and, with a quick movement, plants it on the spot to be cauterized, the patient being hardly able to bear the contact. As for the owner of the foot, the horny sole seems so thick that he feels no pain at all. This is the remedy for the shitjebe blood, probably pleurisy."[41]

---

[38] C. Witt. The Wanderings of Ulysses, ch. 49, 1885, p. 216.

[39] Information by Capt. E. P. Herendeen. In the Ray report on the Eskimo of Point Barrow, 9th Ann. Rept. Bur. Amer. Ethnol., 1887, p. 291, these bundles are described as kindling.

[40] Les marques sincipitales des cranes neolithiques consideré comme reliant la chirurgie classique ancienne a la chirurgie prehistorique. Rev. de l'Ecole d'Anthropologie de Paris, Trezieme Annee, vol. 13, December, 1903.

See also George G. MacCurdy. Prehistoric Surgery—A Neolithic Survival, Amer. Anthrop., new ser., vol. 7 1905, p. 17.

The Cherokee Indians had a heat cure for toothache. The doctor warms his thumb and presses it on the tooth, or he blows smoke from a pipe pressed directly against the tooth.[42]

The most widely distributed of fire customs is the moxa or eschar used for various ills. Beverly quaintly recounts the practice among the Virginia Indians:

"On the part * * * little sticks of lightwood, the coal of which will burn like a hot iron, the sharp point of this they run into the flesh, and having made a sore, keep this running till the humor be drawn off. Or else they take punck (which is a sort of soft touchwood, cut out from the knots of oak or hickory trees, but the hickory affords the best), this they shape like a cone (as the Japanese do their moxa for the gout) and apply the basis of it to the place affected. They then set fire to it, letting it burn out upon the part, which makes a running sore effectually."[43]

The Makah Indians of Cape Flattery, Washington, treat rheumatism by taking a red-hot iron or stick or wisp of cedar bark and burning holes in the flesh. Cautery is the great remedy for all internal complaints, and serves the double purpose of blisters and bleeding.[44]

The Salish of Puget Sound make use of the moxa. Mr. Eells saw a Clallam with a dozen sores on him produced in this way.[45]

The Mapuche Indians of Araucania, South America, prepared balls of dried pith which were lighted and pressed on the skin.

The ornamental arrangement of moxa scars has been observed on the bodies of Buddhist priests and among other natives of the Far East. In the Philippines Legazpi in 1575 "gave such orders as seemed fitting for the government of those provinces which are commonly called the Bisayas de los Pintados because the natives have their bodies marked with fire.[46] This form of tattooing is rare, the cicatrices being usually formed by other means. The first sickness which a Chinese child has, moxa is applied to the crown of the head.[47]

---

[41] H. A. Junod. The Life of a South African Tribe, vol. 2, p. 427, Neuchatel, 1913.

[42] James Mooney. Sacred Formulas of the Cherokee, 7th Ann. Rept., Bur. Amer. Ethnol., 1891, p. 359

[43] Beverly's History of Virginia, 1855, p. 187.

[44] J. G. Swan. The Indians of Cape Flattery, Smith. Contr. Knowl., No. 220, 1868, p. 80.

[45] American Antiquarian, vol. 9, 1886, p. 216.

[46] De Morga. History of the Philippines, Hakluyt Society, London, 1868, p. 19.

Regarding fire in religious ceremonies, Buddhist novitiates are admitted to the priesthood by having their heads burned in the prescribed way by the moxa.[48]

In Korea the priests use a three-prong taper made by twisting soft paper in the form of a cross for burning the skin in self-punishment. Specimens of these rare tapers are in the United States National Museum.

In Japan moxa was in common use and applied ceremonially.

Wood remarks that the Unyoro Tribe of Africa hold the actual cautery in great favor as a method of cure. Many natives are covered with spots from the application of a red-hot iron.[49]

Some other customs of fire healing may be mentioned. The Mexicans cure mosquito bites by holding a coal of fire near the bite.[50]

The Porto Ricans make chiggers "back out" by holding a lighted cigarette or coal of fire to the rear of the insect.[51]

WAR

Fire as a war agency has an extended history. Its development has been tremendous with the advancement of science. It enters now in many ways for the killing of men. The early methods reflects the crudity of the stages of man's developement in the arts and industries and are found in use among various tribes. These vary from direct attack to strategic burnings, the hurling of heated missiles, pitch, oil, and lead. A method of attack widely known was by fire arrows, an extension probably of an earlier throwing of firebrands.[52] The Wa Chaga of the Mount Kilima-Njaro region, British East Africa, used fire arrows as an incendiary weapons.[53] The Lacandones of Chiapas, Mexico, threw lighted fagots into the enemy's camp and in the confusion made reprisals.[54]

The North American Indians generally shot fire arrows when their use was practicable. They also made a hurling weapon not heretofore described, which consisted of a heavy wood missile with bulbous head and flexible shaft, capable of being thrown a long distance and having a direct, steady flight. The head of the weapon was bound with an inflammable material and the missile thrown. This weapon is more effective than the arrow and more primitive. Specimens from the southern Plains tribes are in the United States National Museum.

---

[47] Information by W. W. Rockhill.

[48] Douglass. History of China. p. 360.

[49] J. G. Wood. Natural History of Mankind, 1870, vol. 1, p. 468.

[50] Information by Dr. Ales Hrdlicka.

[51] Information by Dr. E. R. Hodge.

[52] H. H. Bancroft. Wild Tribes, 1874, vol. 1. p. 697.

[53] Information by Mrs. French Sheldon.

[54] H. H. Bancroft. Wild Tribes, 1874, vol 1, p. 697.

Among the rare combats engaged in by the Hopi Pueblo Indians was the destruction of Awatobi in 1700. The attackers here, knowing that most of the warriors and important men would be holding a ceremony in an underground room, entered by a hatchway, threw down into this room lighted wood and red peppers, with the complete results anticipated.[55]

FIRE ALARMS AND PREVENTION

Naturally in the ages during which man has been in close companionship with fire some methods of protection and prevention would be invented. The benefits and disadvantages of fire are set against each other here. From the first times to now fire has played the part of a destroyer, and while man has bewailed his loss and described it in money and other terms, no one has said anything against fire. This psychology is so implanted that fire has never been subject to radical doctrines.

There are many signals and alarms to announce conflagrations, and traces of organizations to fight fires, showing early cooperations. Methods of placing buildings also and character of structures have developed. Architecture itself has been influenced by needs of fire prevention.

The Orokos of Yezo, Japan, have a fire alarm consisting of two small oval pieces of wood on the same principle as castanets, which are clapped together to announce fire.[56]

"Each hut generally has a small plot of land to itself. This is done as a protection against fire, of which the Ainu are very much afraid. In fact, the Japanese affirm that the Ainu fear a fire and the fire goddess so much that if a house once takes fire they will not even attempt either to extinguish it or save any of their property. They will not be so foolish as to rob the fire goddess of that which she desires to have. This, however, the Ainu deny. The Japanese have made a mistake, and the fact is that when an Ainu hut once catches fire there is no time to save anything, for the thatch naturally burns very rapidly indeed.

"I have seen two huts on fire, and they were both burnt down in less than 15 minutes. In one case a few things were saved, but in the other the household only managed to save themselves and the clothes they had on. The Ainu are not so senseless as to attempt the impossible—that is, to put out the flames of a burning hut—but they do all they can to save their treasures, especially their heirlooms, and to prevent the fire from spreading. The Ainu call or alarm of fire is a shrill, weird, unearthly noise, somewhat resembling the note of the screech owl, and can be heard for a great distance. The women can best utter the scream; the men generally call out 'Wooi!'"[57]

---

[55] J. Walter Fewkes. Awatobi: An Archeological Verification of a Tusayan Tradition, Amer. Anthrop., vol. 6, October, 1893, p. 363.

[56] Edward Greey. The Bear Worshippers of Yezo, Boston, 1884, p. 261.

The problem among uncivilized tribes relating to saving the food supply from fire no doubt in part has had much to do with the storing of such supplies in caches in the earth or plastered graneries. In civilization, where cities may be enormous aggregations of inflammable material, structures like the Chinese godowns appear. The contest, however, between fire and fireproof structures is maintained to this day with doubtful results.

A curious regulation, evidently intended to prevent fires by insuring precautions on the part of householders, is found among the Kha Tahoi of Laos:

"In case of the partial or complete burning of a village the owner of the house where the fire took place must pay two buffalo (one white and one black). The sacrifice of their buffalo, which lasts three days, is preceded by a sacrifice of chickens, which equally lasts three days. It was then six days during which the village is *khalam*. At the same time, if a passing stranger is in the house where the fire starts he is compelled to pay the fine of two buffalo."[58]

TIME BY LIGHT AND FIRE

Somewhere in the course of man's acquaintance with fire, presumably quite late in the growth of ideas, time was associated with light and fire. Using natural light there is noted the sundial, which has great antiquity, and back of this crude gnomons of limited uses and value. It is not likely that how long a piece of wood or a fire burned was within the consciousness of early man, as manifestly the idea was of no consequence in his rude life. There must be taken to explain this topic methods that have a primitive cast found among various peoples. A full and interesting account of the measure of gross time by fire is given by Bartram, who observed the custom among the Attassee Indians of Muskhogean stock in Alabama.

"Bundles of dry cane are broken in pieces to about the length of 2 feet, and then placed obliquely crossways upon one another on the floor, forming a spiral circle round about the great center pillar, rising to a foot or 18 inches in height from the ground; and this circle spreading as it proceeds round and round, often repeated from right to left, every revolution increases the diameter, and at lenth extends to the distance of 10 or 12 feet from the center, more or less, according to the length of time the assembly or meeting is to continue. By the time these preparations are accomplished it is night, and the assembly have taken their seats in order. The exterior extremity or outer end of the spiral circle takes fire and immediately rises into a bright flame (but how this is effected I did not plainly apprehend; I saw no person set fire to it; there might have been fire left on the earth; however, I neither saw or smelt fire or smoke until the blaze instantly ascended upwards), which gradually and slowly creeps round the center pillow with the course of the sun, feeding on the dry canes, and affords a cheerful, gentle, and sufficient light until the circle is consumed, when the council breaks up." [59]

---

[57] Rev. John Batchelor. Ainu of Japan, New York, 1903.

[58] M. Daupley. Les Kha Tahoi, Bull. Soc. Ethnogr. de Paris, new ser., vol. 3, 1914, p. 47.

Other tribes of southern Indians observed this custom, which is in advance of the practices of any of the tribes of the Eastern Hemisphere so far as noted.[60]

FIRE MAKING BY ARTIFICIAL MEANS

The presumed systematic order of the processes by which fire is gotten artificially is shown in a synoptic series exhibited in the United States National Museum. This series patently assembles a number of devices each having an independent history, and therefore can only be regarded as suggestive of the order of development based on the grade of inventive ability expressed in their structure and function. The series is described as follows:

1. Volcano in action. Lava setting fire to forest (pl. 27, fig. 1).
2. Lightning setting a forest on fire (pl. 27, fig. 2).
3. Camp fire. Man borrowing fire (pl. 27, fig. 3).
4. Fire saw. Strip of bamboo drawn across a section of bamboo. Dyaks of Borneo and other Malays.
5. Fire thong. Rattan thong drawn over a grooved piece of wood. Dyaks of Borneo.
6. Fire plow. Blunt stick worked along a groove in a lower stick. Polynesians.
7. Fire drill. Slender rod twirled between the hands upon a lower stick having a cavity with slot. Indians of the United States and widely diffused in the world.
8. Fire drill. Rod held in a socket and gyrated by means of a cord. The lower piece of wood has a cavity with slot, opening upon a shelf. Eskimo of Alaska.
9. Fire drill. Rod held in a socket and gyrated with a bow and cord. Lower piece with cavities on a central groove. Eskimo of Alaska.
10. Fire drill. Pump drill used specially for sacred fire. Iroquois Indians, Canada.
11. Strike-a-light. Flint and iron pyrites struck together as the ordinary flint and steel. Eskimo of Alaska.

---

[59] John Bartram's Travels. Dublin, 1793, pp, 449–450. The lighting of the fire which mystified Bartram was from the fire buried under the council house, mentioned on p. 31.

[60] See paper on this subject in Amer. Anthrop., vol. 6, April, 1893.

12. Strike-a-light. Flint and steel and box for holding flint, steel, and tinder. Sulphur-tipped splint ignited from the tinder. England.

13. Strike-a-light. Bamboo tube and striker of pottery, used as flint and steel. Two boxes for tinder. Malay.

14. Tinder pistol. Gunlock adapted for throwing sparks into tinder. England.

15. Strike-a-light. Combination of flint, steel, tinder, and extinguisher, for carrying in the pocket. Spain.

16. Fire syringe. Cylinder with closely fitting piston bearing tinder. Driving the piston down smartly kindles the tinder. Siamese and Malays.

17. Lens. Used for producing fire by focussing sunlight upon tinder. Ancient Greeks.

18. Hydrogen lamp. Hydrogen gas is made to play upon spongy platinum, causing it to glow. Germany, 1824.

19. Match-light box. Bottle of sulphuric acid, into which splints tipped with potassium chlorate and sugar were dipped. Vienna, 1809.

20. Matches. Various kinds of phosphorus matches.

21. Electric gaslighter. Cylinder containing a small dynamo run by pressure of the finger, producing sparks between the points at the upper end of the tube. United States, 1882.

On the physical side the following means have been employed for getting fire, namely, 1, muscular energy is converted into heat by friction and arrest of motion, as in the drill and flint and steel; 2, the energy of the concentration of heat rays by the lens and concave mirror; 3, the energy of the compression and occlusion of gases, as in the aerophore and hydrogen lamps; 4, the energy of chemical combination, as in matches, pyrophores, sodium, etc.; and 5, the energy of electrical force, as the sparking apparatus. The sucessive methods form a series coincident with the order of man's adaptation and utilization of the forces of nature.

ETHNOGRAPHY OF THE FIRE DRILL

ANCIENT

There are ancient references to the fire drill which are of some interest. As these occur in the period of advanced civilization, their bearing on the early stages of the invention is not particularly important. Indeed, the earliest references show only the record of a survival from an indefinite time, perhaps very ancient, but showing no more than the practice of a savage tribe as at the present. Unquestionably the invention is very ancient and in a stage of society when writing was unknown, though archeological evidence is not forthcoming to place the invention in any of the past human periods. The evidence of the complexity of the problems involved in the invention rather than the discovery of the art of making fire with a drill may not allow placing of the period farther back than the Neolithic, thus assigning previous periods to the stage of preservation of fire. Biblical references may be found in Ezekiel XIX: "And a fire is gone out of a rod of her branches which has devoured her fruit," may afford ground for supposing that the Jews were acquainted with fire making with the drill. In Ezekiel XXI a more distinct reference is given: "The King of Babylon will take his station at the cross road, where an old road branches off in two directions, to have recourse to divination to kindle fire with the staff and to interrogate images." It is known the Akkadians made fire by revolving two pieces of wood.[61] The cuneiform character for the Assyrian fire god, Gibil, "reed fire," is a fire drill. The cord drill was in use in Homeric times.[62] In the tool basket of an ancient Egyptian carpenter of Thebes were found drill bows and the nut or socket of wood in which it was worked. Pictures of such a drill are found on tombs of the IV and V dynasty.[63] It is probable that the Egyptians made fire with this device. In the Settle cave in Yorkshire, England, objects supposed to be drill-cord handles were found. These refer to the Neolithic and Roman period.[64]

EUROPE

In the course of the profound advancement of Europe in civilization the ancient methods of producing fire by wood friction long since passed out of practice. Only as cult survivals and occasionally for practical needs did this primitive art remain to indicate its former prevalence in Europe. Students of folklore have collected many of these, and Frazer's Golden Bough recites a number of instances.

In 1892 the writer collected from Henry Walther, an employee of the Smithsonian Institution born in East Prussia, in territory formerly belonging to Poland, a first-hand relation of this method of making fire about the year 1825. Mr. Walther related that the boys, who were on watch in the fields while the potato crop was being gathered, would sometimes make a fire by wood friction. Two stakes were fastened in the ground and a spindle pivoted between them horizontally. A cord was passed over the spindle and the latter revolved smartly and after a short time the tinder held at one of the bearings would ignite. The wood used was dry willow. The operation was not performed as a sport or from curiosity, but as a necessity, since the flint and steel must needs remain in the kitchen.

The same apparatus was used in Essen in Hanover in 1828 to produce the alarm fire. In the Swiss Cantons this ancient method is still known, and a specimen of the apparatus is shown in the Neufchatel Museum. It can be traced in practically every country of Europe. A description of its use in various parts of eastern Europe was published by Frederick Kunze.[65]

---

[61] W. St. Chad Boscawen. Trans. Soc. Bibl. Arch., vol 6, 1878, p. 279.

[62] Odyssey, Book 9, p. 282.

[63] Sir Gardner Wilkinson. Ancient Egyptians, vol. 1, London, 1837, p. 401.

[64] W. Boyd Dawkins. Journ. Anthrop. Inst., vol. 1, 1872, p. 64.

The horizontally worked drill is peculiar to Europe.[66]

"The regin-naglar which stood in the pillars (high seat pillars of early northern temples) may have been pegs used for ignition by friction, perhaps for the rekindling of the perpetual fire, which, in view of certain customs existing in later times, may have been extinguished once a year. Or again it may have been for the kindling of the 'need fire,' which was also perhaps connected with the cult of Thor; cf. Adam of Bremen IV, 26; si pestis uel fames imminet Thor ydolo libatur. In later times the sparks for the kindling of the 'need fire' were sometimes obtained by twisting a wooden peg round in an oaken post (cf. Grimm, Deutche Mythologie, vol. 1, p. 502)."[67]

ASIA

As the swarming place of nations, it appears natural that every fire-making device known to man should be found in Asia. The vertically worked drill, however, is the characteristic implement for the great part of the continent.

NORTHERN ASIA

West of Bering Strait the Siberian Eskimos use the machine with vertical drill called the bow drill, as do the Alaskan Eskimo. The Chukchis, who live in northeastern Siberia between the Anadyr River and the Arctic Ocean, also use the bow drill (pl. 28, fig. 1).

Nordenskijold says:

"Fire is lighted partly in the way common in Sweden some decades ago by means of flint and steel, partly by means of a drill implement. In the former case the steel generally consists of a piece of a file or some other old steel tool, or of pieces of iron or steel which have been especially forged for the purpose. * * * The flint consists of a beautiful chalcedony or agate, which has been formed in cavities in the volcanic rocks which occur so abundantly in northeastern Asia, and which are probably also found here and there as pebbles in the beds of the tundra rivers. As tinder are used partly the woolly hair of various animals, partly dry fragments of different kinds of plants. The steel and a large number of pieces of flint are kept in a skin pouch suspended from the neck. Within this pouch there is a smaller one containing the tinder. It is thus kept warm by the heat of the body, and protected from the wet by its double envelope. The other sort of fire implement consists of a dry wooden pin, which by a common bow drill is made to rub against a block of dry, half blackened wood. The upper part of this pin runs in a drill block of wood or bone. In the light-stock holes have been made to give support to the pin, and perhaps to facilitate the formation of the half carbonized wood meal which the drilling loosens from the light-stock and in which the red heat arises. When fire is to be lighted by means of this implement one foot holds the light-stock first against the ground, the bowstring is put around the drill pin, the left hand presses the pin with the drill block against the light-stock, and the bow is carried backwards and forwards, not very rapidly, but evenly, steadily, and uninterruptedly, until fire appears. A couple of minutes are generally required to complete the process. The women appear to be more accustomed than the men to the use of this implement. An improved form of it consisted of a wooden pin on whose lower part a lense-formed and perforated block of wood was fixed. This block served as flywheel and weight. Across the wooden pin ran a perforated crossbar which was fastened with two sinews to its upper end. By carrying this crossbar backwards and forwards the pin could be twined round with great rapidity. The implement appears to me the more remarkable as it shows a new way of using the stone or brick lenses which are often found in graves or old house sites from the Stone Age."[68]

---

[65] Internat. Archiv f. Ethnogr. Leiden, vol. 13, 1900, p. 81.

[66] See Dr. Friedrich S. Krauss. Altslavische Feuergewinnung, Globus, vol. 59, 1891, p. 317.

[67] H. M. Chadwick. Jour. Roy. Anthrop. Inst., vol. 30, new ser., vol. 3, 1900, pp. 37-38.

Among the Tuski of Siberia the women light the fire with the drill, a custom which is at variance with that of most peoples. The reference of fire making to man is almost universal.

"A piece of flat board has a number of small holes made in it, into one of which one end of a pointed stick is placed, the other extremity fitting into a sort of breastplate put on by the woman officiating, who with a bow works the stick to and fro rapidily, just as in drilling a hole. In about 10 minutes, under favorable circumstances, she succeeds in detaching burning fibers of the wood; these are hastily put into a handful of dried grass, which envelopes them, and by rapid motion through the air kindles into flame. This is a most laborious operation.[69]

The Koryaks live south of the Chukchis, between the Anadyr River and the central part of the Peninsula of Kamchatka. In her compilation of the work of various Siberian explorers Miss Czaplicka describes the sacred implements for fire making used by the Koryaks and the customs connected therewith.

"The Koryak 'guardians' and 'charms' serve as protectors to individuals, families, or villages, whereas such greater supernatural beings as The Master on High, Big Raven, and the malevolent kalau are deities or spirits of the entire tribe, excepting those kalau that serve individual shamans. 'Guardians' form a class of objects that avert evil from men. Those about which Jochelson was able to obtain information include the sacred implements for fire making, which comprise a fireboard (gicgic or gecgei), a bow (eyet), a wooden drill (maxem, 'arrow,') and a headpiece of stone or bone (ceneyine).

---

[68] Nordenskjold. Voyage of the Vega, vol. 2, 1881, pp. 120–122.

[69] W. H. Hooper. Tents of the Tuski, New York, 1879, p. 187.

"The fireboard is of dry aspen wood, which ignites easily, and has holes in it for receiving the drill. It is shaped roughly to resemble a human being. The consecration of a new fireboard to the office of protector of the hearth and herd is accompanied with the sacrificing of a reindeer to 'The Master on High,' the anointing of the fireboard with the sacrificial blood and fat, and the pronouncing of an incantation over it. It would thus appear, Jochelson thinks, that the power to direct some vaguely conceived vital principle residing in a crude inanimate object to an activity beneficial to man lies in the incantation pronounced over it.

"The headpiece has a hollow socket, which is placed upon the thin upper end of the drill. 'The headpiece is held by one person, the board by another, while the bow is turned by a third person,' the drill rotating on its thick lower end in one of the holes of the fireboard. The charcoal dust produced by drilling is collected in a small leathern bag, for it is considered a sin to scatter this dust."[70]

That the bow drill was in general use in Siberia is shown by the quotations presented and the following by Bush:

"The natives (Koraks, Lamuts, Tungus) on the west shore of Okhotsh Sea use agates as flints, tinder from the fungi of the birch boiled in lye, in fire making. They also use the fire drill. Sulphur is well known, and each one wears suspended to his tinder bag a small bone or wooden basin of it, in which to put the tinder when lit and by blowing create a blaze."[71]

JAPAN

The Ainos of Yezo commonly use the simple two-stick drill, but it is recorded that they also had the bow drill, in common with the Siberians.[72]

So far as can be ascertained by the writer the bow drill was not known to the Japanese. Singularly, it appears not to be included among the tools belonging to any of the arts of Japan. The simple drill, however, is the common tool. The primitive fire drill survives only in sacred usages. "The fire drill used at the Shinto temples of Ise is far more complicated in construction, and certainly represents a much more advanced stage of mechanical knowledge than the Kitzuki fire drill indicates."[73]

---

[70] M. A. Czaplicka. Aboriginal Siberia. A study in social Anthropology, Oxford, 1914, pp. 265-266.

[71] Bush. Reindeer, Dogs, and Snowshoes, New York, 1871, p. 323.

[72] B. Douglas Howard. Life with Trans-Siberian Savages, New York, 1893, p. 83.

The Koreans know the method of making fire by wood friction, but it is not practiced at present.[74]

The Taiyals of Formosa employed the pump drill for producing fire used in ceremony. The fire saw and hand drill are also found here.

CHINA

It is difficult in the older civilizations, as China, to trace the use of the fire drill or other fire-making apparatus except the modern flint and steel. It is probable that there exist historical references and even survivals of religious custom which would show some method of making fire with wood friction, as in India. Dr. Berthold Laufer has brilliantly covered the ground as to the use of lenses in China.[75]

INDIA

The simple two-stick drill is found in various parts of India among the less-advanced tribes. The method of working is identical with that found in other countries. The sacred drill is worked by a cord as the European, but vertically instead of horizontally. Moor, Hindu Pantheon, 214, says that a bow was used. He states that the wood for the drill was *Adenanthera aculeata* or *Prosopis aculeata.* If these could not be procured the *Pipala,* resemblng our poplar, was employed. An ancient reference to this drill is found in Milinda panha, the questions of King Milinda. This Milinda panha dates probably from the early part of our era, and is still famous in northern Buddhist countries. Referring to the question of the gradual formation of qualities, Nagarena uses the following illustration: "Suppose, O King, there were no fire-stick apparatus, no twirling stick, and no cord for the twirling stick, and no matrix, and no burnt rag for tinder, and no human effort and exertion, could there be fire by attrition?" Again, he says: "Suppose, O King, there were no burning glass, and no heat of the sun, and no dried cow dung for tinder, could there be fire?"[76]

The Veddas of Ceylon illustrate with what facility the lowest of mankind produce fire when it is needed:

"One of them took his arrow, broke it into two pieces, sharpened the one like a pencil and made a hole in the other to receive its point; then placing the latter on the ground and holding it down firmly with his toes, he whirled the pointed one round in the hole, rolling it rapidly between the palms of his hands. In a few moments it began to smoke, a little charcoal then fell in powder, and presently a spark jumped out, kindled the charcoal dust, and the end was accomplished." [77]

---

[73] Lafcadio Hearn. The Most Ancient Shrine in Japan. Atlantic Monthly, December, 1891, footnote, p. 792.

[74] From Pom K. Soh.

[75] Optical Lenses. 1. Burning-lenses in China and India, T'ornig-pao, vol. 16, May 1915. Brill, Leiden.

[76] T. W. Rhys Davids. Sacred Books of the East, vol. 35, 1882, p. 85.

MALAYSIA

While in Malaysia there is the greatest proliferation of fire-making methods, the simple drill is in the hands of those tribes lowest in the scale of culture.

The Dyak are said by Wood to drill down onto a groove cut in the under side of the block of wood technically called the hearth. If this observation is correct this method appears to connect with the sawing methods.[78]

The North Borneans also as one of their methods use the plain hand drill.[79]

Marsden observed the use of the drill in Sumatra.[80]

The Nias islanders used a cord drill and also had the pump drill.[81]

Doctor Pleyte has made an interesting study of fire-making apparatus in Indonesia, to which attention is called.[82]

AUSTRALIA

Captain Cook observed that the Australians used the simple fire drill like the Sitkans.[83] This observation, although based on quite incomplete knowledge of Australian aboriginal methods at the time, is generally true. Another method has been introduced, however, from oceanic peoples and will be noted under plow. A strikingly primitive use of the drill is noted by R. Brough Smyth:

"Mr. Robert Hugham says that the aborigines of Burnett, New South Wales, get fire in the following manner: They cut with the hatchet a hole in a dry fallen tree. They fill this hole with part of the dry ripe head of the flower stalk of the Xanthorrhoea, well powdered between the hands, and then turn the stem head downward into the hole and twirl it. In a few seconds they get fire.[84]

The Tasmanians were supposed to be an example of a fireless people. "Against this opinion we have abundant evidence that they did know how to produce artificial flame. * * * The natives got two pieces of grass-tree stems, the smaller of which had a hole in it. Some soft down of the inner bark of trees called bull's-wool was mixed with powdered charcoal and placed in the hole. Friction with the other stick ignited the mixture, and flame was the result."[85]

---

[77] J. E. Tennent. Ceylon, etc., London, 1859, vol. 2, p. 541.

[78] J. G Wood. The Natural History of Man, vol. 2, 1870, p. 502.

[79] S. J. B. Skertchley. Journ. Anthrop. Inst., vol. 19 1890, p. 448. Says that the drill is used by the Malays, Dyaks, Dusans, Bajours, Cagayans, Sulus, Muruts, Bugis, etc.

[80] William Marsden. Sumatra, London, 1811, p. 60.

[81] Modigliani. Un Viaggio a Nias, pp. 385, 587.

[82] Globus, vol. 59, 1891, pp. 52–56.

[83] First voyage, vol. 3, London, 1893, p. 234.

[84] Aborigines of Victoria, 1878, vol. 1, p. 395.

[85] Bonwick. Daily Life of the Tasmanians, London, 1870, p. 20. In Spencer's Descriptive Sociology, vol. 3, p. 49.

AFRICA

Africa is a continent in which the simple drill is almost exclusively employed in fire making. Except on the Mediterreanean fringe, there is no rudimentary machinery for actuating the drill. With some degree of probability the Egyptians are supposed to have used the bow drill for making fire. In the Egyptian Sudan the natives are said to mount the drill in a frame and revolve it by means of a wheel and crank. No information can be procured as to this device, but if true this method is unique in the history of the drill. The Bushman description of fire making from a tree is applicable to all Africa:

"The tree's name was | n'au- | kumm; and (he had) two sticks; the fire stick (that is, the one which he held in his hands) was long, small, and long like a reed. The other (fire) stick lay on the ground; for he had laid (it) the other stick upon grass; he rubbed fire, the fire fell upon the grass; and he took up the fire (that is, the grass); he blew the fire." [86]

The following extract from the admirable work of H. A. Junod relates to fire making and fire customs among tribes of southern Bantu:

"As regards fire (*ndjilo, mu-mi*), the Honwans knew it already before the fifteenth or sixteenth century. The tradition of Shokishahumba shows that among the Hlengwe there was a time when food was not cooked.

"There are four trees used to produce fire by friction (*tsika*): 1. The bulolo, a kind of hibiscus growing in the estuary of the Nkomati, in the region regularly watered by the tide, is the best ntsiko or wooden flint. It is a very light and soft wood and is still used near the coast, though matches are now to be found everywhere. 2. The mpahala (*mu-mi*), a bush of the Compositae family, whose wood is very hard and used to make handles for hoes. It grows all over Thongaland, in the plain as well as in the mountainous regions. 3. The nkewa (*mu-mi*), the large wild fig tree, which covers the banks of the Nkomati and the Maputju Rivers, and is common in the lowlands. 4. The ntjopfa (*mu-mi*), the wild custard tree, employed to light the sacred fire of nyokwekulu (vol. 1, p. 364). It is taboo to use it for ordinary purposes, or to warm oneself at its embers. Medicine men only are allowed to make ntjopfa fire, having drugs to prevent the disease caused by its use.

"Dealing with fire taboos, I may add that it is taboo to use branches of a tree which has been struck by lightning; taboo also to keep alight the fire of a deceased person after the conclusion of the great mourning. It must be ritually extinguished, the idea being that it participates in the general contamination of death (vol. 1, p. 135).

---

[86] Specimens of Bushman Folklore. Collected by W. H. I. Bleek, Ph. D., and L. C. Lloyd. Edited by the latter. London 1911, p. 413, note, which is a translation of | Kun text. For illustration of these sticks see fifth plate between pages 432 and 433.

"Gungunyane used to levy a tax on fire. He ordered all the fires of his kingdom to be extinguished at a certain time, and sent messengers to relight them by means of embers procured from the royal kraal. Each village had to pay a tax for the new fire. It seems that this kind of royal right was exercised in the old times by the famous Monomotapa king. Nothing of the kind is met with amongst the more modest Thonga chiefs.

"The manner of producing fire with the wooden flint is as follows: A dry branch of the tree is secured, from half an inch to an inch thick, and cut into two pieces, each of about 18 inches in length; one half is called the wife (*nsati*), the other half the husband (*nuna*). The first piece, the female, is laid on the ground and a notch is made in it with a knife; the notch is cut in two movements, first on the upper part of the wood, secondly on the side of it. The male is then somewhat rounded, inserted perpendicularly in the notch, held firmly between the palms of the hands and made to revolve by a rapid motion of the hands rubbing it from top to bottom. The operator having reached the bottom of the male at once starts again from the top; so the frictions follow each other immediately. The motion widens the notch in the female to such an extent that the male penetrates and begins to burn it; the ashes find their way out by the lateral notch; a little dry grass has been placed there and soon begins to smolder. An expert obtains fire after six or seven consecutive frictions, especially when using bulolo.

"Embers are kept burning as much as possible the whole night on the fireplace. Should they, however, have been allowed to go out, the mistress of the kitchen will send her daughter to the neighboring hut or village to fetch a glowing cinder. This is called 'ku woka.' The ember will be carefully brought on a sala shell or occasionally in a big snail shell."[87]

"Fire is kindled by the Bedouin when necessary by the common method of rubbing one piece of wood against another. The Somal call the process 'muddick.' One stick, about a foot long, is made smooth to fit the hands conveniently, and with a point at one end. The other stick is nicked nearly completely around the circumference. The nicked stick is held on some smooth surface, as the sole of a shoe, and the pointed stick is twirled by being rubbed rapidly between the palms of the hands until wood dust falls down along the nick in the other stick. This catches fire by friction.

"I was shown several very dry-looking kinds of thorn trees which supplied the best kinds of wood for this process."[88]

---

[87] H. A. Junod. The Life of a South African Tribe, vol. 2, p. 32–34, Neuchatel, 1913.

[88] Carleton. Journ. Anthrop. Inst., London, 1892, vol 21, p. 167.

The following is the most detailed description of fire making from any observer, and refers to the Akikuyu, East Africa.

"No tradition or explanation of the origin of fire exists amongst the Akikuyu, nor has it any place in social or religious ceremony. It is produced in one way only, the by-friction between two pieces of wood. The implements for making it vary but slightly in pattern.

"The upper, or drill, stick (*u-lin-di*) is a straight rod like a lead pencil, 13 inches to 24 inches in length and 1 inch to 1¼ inches in circumference. The lower end is convex. When using the longer drill of 24 inches the palms of the hands are not applied more than two-thirds of the way up. It may perhaps be well here to explain that to obtain fire by the friction between two pieces of wood it is essential that one shall be hard and the other soft, of which the harder shall be the drill. Again, not any drill will do with any fire stick. The texture of the wood of the one has to bear a certain relation to the texture of the wood of the other in order to produce fire. The Akikuyu say in explanation that 'one is the man and the other is the woman.' The upper or drill stick (*u-lin-di*) may be made of the wood of the following trees:

"Ni-u-gu-o; mu-lin-di-ki; mu-gu-mu; mu-chu-gu; mu-gi-o; ru-gu-tu or ka-gu-tu (? *veronia,* species); mu-cha-sa (*veronia,* species); mu-li-ka (? *veronia,* species).

"The lower or fire stick (*je-ka*) is made of an altogether different wood. It is of the pulverized tissues of this stick that the tinder is formed and gradually brought to a glow by the friction of the drill.

"It is oval in sections, 9 inches to 12½ inches long by 1½ inches to 2½ inches in circumference, flattened on its lower aspect, and tapered to a point at either extremity. On the upper surface of its middle third about half a dozen cavities, the size of half a pea, are formed to receive the end of the drill. The wall of each cavity is cut down to its bottom at one point, and a tiny gutter made to proceed from it. Down this gutter the pulverized woody fiber insensibly trickles as it escapes from beneath the drill. None of it remains in the cavity of the fire stick. This lower block or fire stick may be made of the wood of the following trees.

"Mu-rin-ga; mu-chu-gu; mu-i-goi-a; mu-te-i (? *veronia*); mu-re-vu.

"To make fire two natives proceed as follows: One from his quiver takes his drill and fire stick. From his scabbard he draws his sword. They sit on their heels opposite to one another. The sword lies on the ground between them, its point directed towards the man about to use the drill. The assistant then firmly holds the fire stick transversely across and a little above the tip of the weapon, and places a small handful of dry, crumpled grass handy.

"The fire maker then rubs the palms of his hands and also the tip of the drill on the dry ground, and drops a minute quantity of earth into the chosen concavity on the fire stick. In this cavity the convex end of the drill is now placed. He then applies the flattened palms of his hands to the upper end of the drill. Proceeding quite slowly, he causes the drill to rotate by moving the flattened palms backwards and forwards against each other, at the same time steadily pressing the drill downward into the cavity of the fire stick. As the palms pass down the stick the speed of rotation is gradually increased to the maximum.

"When the lower borders of the hands have arrived within 6 inches of the fire stick the third and little fingers of the left hand are thrown around the drill to retain it firmly in position, whilst the right hand is rapidly thrown upwards to enable its third and little fingers to grasp the upper end of the drill. By the right hand the drill is now retained in position, whilst the left is released and brought upwards opposite to its fellow. The flexed fingers are now extended and the flattened palms, again opposed to one another, make another journey down the length of the drill.

"As the drill rotates smoke appears, whilst the powdered wood of the fire stick, gradually dribbling down the gutter made in its side leading from the cavity in which the drill is rotating, forms a little mound on the sword blade. The particles forming the pile cohere, but do not smoke or glow. When the mound has attained to the amount that would lie on a threepenny piece it is found by experience that a portion of it, the size of half a pea, can be blown up into a solid red-hot ember. The man, therefore, having made his little pile, leisurely picks up a few blades of dry grass, onto which he tilts from the sword blade the little mound of coherent dust and incloses it in the grass. He gently blows on it three or four times, whereupon the grass bursts into flame.

"Thirty or forty seconds is the average time required to produce the mass ready to blow up. A flame is fairly uniformly started in three-quarters of a minute from the time of beginning to drill. This statement is based on a number of observations carefully made with a stop watch"[89] (pl. 28, fig. 2).

WESTERN HEMISPHERE

It is clear that in the Western Hemisphere the wood fire drill is universal. That no other forms of wood friction apparatus have been introduced argues the unity of American culture and its long continuance without modification of extraneous influences. Outside of the northern area the fire drill has remained simple, without mechanical additions.

---

[89] W. S. and Katherine Routledge. With a Prehistoric People: The Akikuyu of British East Africa, London, 1910.

ESKIMO

The cord and the bow drill are used extensively by the whole Eskimo race. The cord is prevalent in the area opposite the contact points with Asia, and gradually diminishes above and below this focus. The cord drill requires the services of two men, and the bow drill is easily handled by an individual. Owing to the limited selection of good material for the drill, it would seem that a mechanical method giving more power indicates a necessity for the Eskimo appliance, but the distribution of the cord and bow drill over the north of Asia in regions where excellent wood is abundant weakens this suggestion. It is nevertheless true that the mechanical drill is most useful in the environment of the Eskimo. Some of the Yukon tribes and also the Chukchis know the use of the pump drill for making fire. Environmental conditions of ice and snow are reflected in the form of the hearth of the fire drill, which is formed so that the drill works on a central groove which takes the place of the slot or it has a step on which the dust falls. The surprising facility with which the native makes use of his surroundings has been remarked by many observers. For example: "He cut a stout stick from a neighboring larch, and taking out the leather thong with which his moccasins were tied, make a short bow and strung it. He then searched for a piece of dry wood, and having found it, cut it into shape, sharpened both ends, and twisted it once round the bowstring; he then took a bit of fungus from his pocket and put it into a little hole which he made in another piece of dry wood with the point of the knife. A third piece of dry wood was fashioned into a handle for his drill."[90]

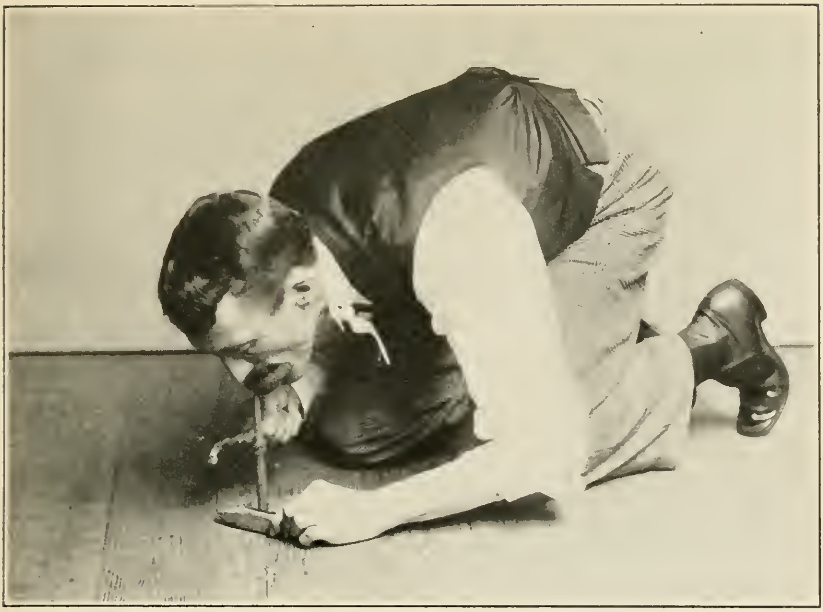
On many parts of the Alaskan coast matches superseded the fire drill, and in some cases the art was lost. At Koniganok, Chagoin Bay, Cape Newenham, in 1918 and 1919, matches having given out, the Eskimo were forced to revive the fire drill, "two-man outfit" (pl. 29, fig. 1). They assembled the following parts: The fire drill, of *Populus balsamifera,* "oo shee ka tuk"; the hearth, of drift spruce, "ka nin"; a bearded seal thong, "a ghol lan tuk"; handles of bird bone, "end dwellers," "vi kog meautat"; and with these and the drill socket they got the desired fire.[91]

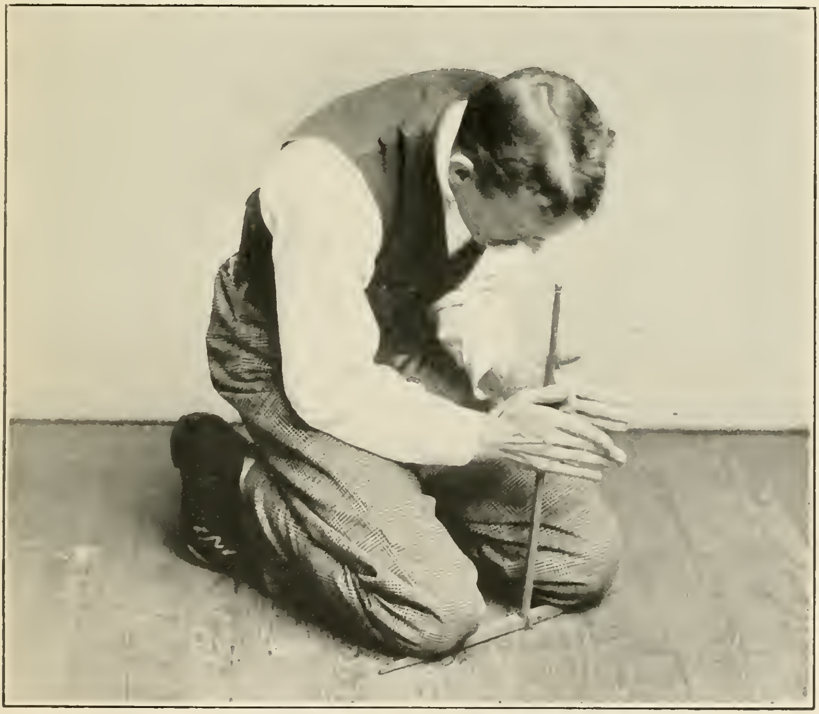
Nelson has worked out the drill carefully for the Norton Sound Eskimo (Cat. Nos. 33, 166–178, U.S.N.M.). The name of the fire drill is in Unaleet, *oo joo gu tat;* mouthpiece, Unaleet, *na qhoo tuk,* Malemut, *nukh eruhn;* of the drill, Unaleet, *oo joo qa tuk;* of the tinder wood, Unaleet, *athl uk;* of the bow, Unaleet, *ar rhu low shuk,* Malemut, *pish ik sin rik.* The drill for boring is in Unaleet *e guhn;* the drill bow, in Malemut, *pat uk.* On one mouthpiece (903) two

---

[90] H. Y. Hind. Explorations in Labrador, vol. 1, London, 1863, p. 149.

[91] Information by D. E. Stubbs, Amak, Alaska.

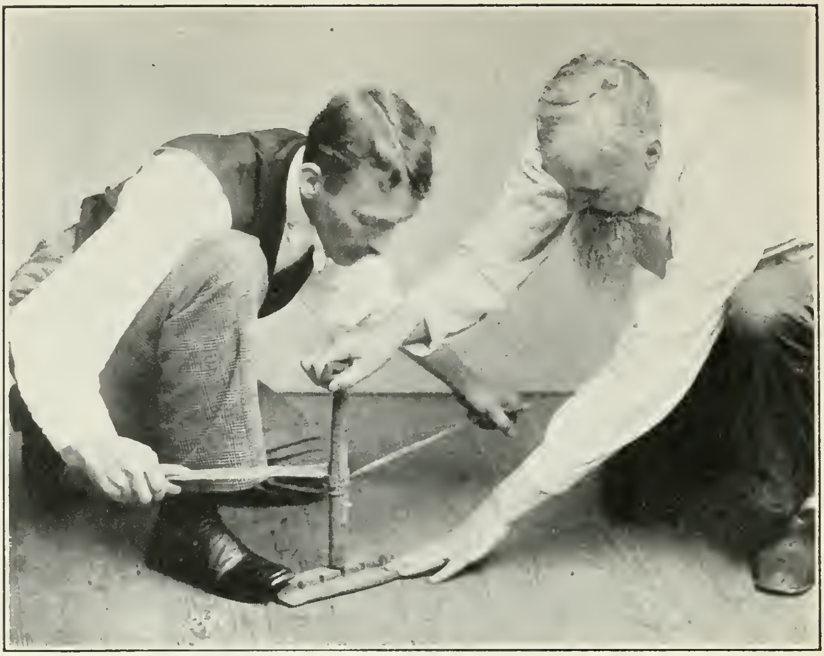


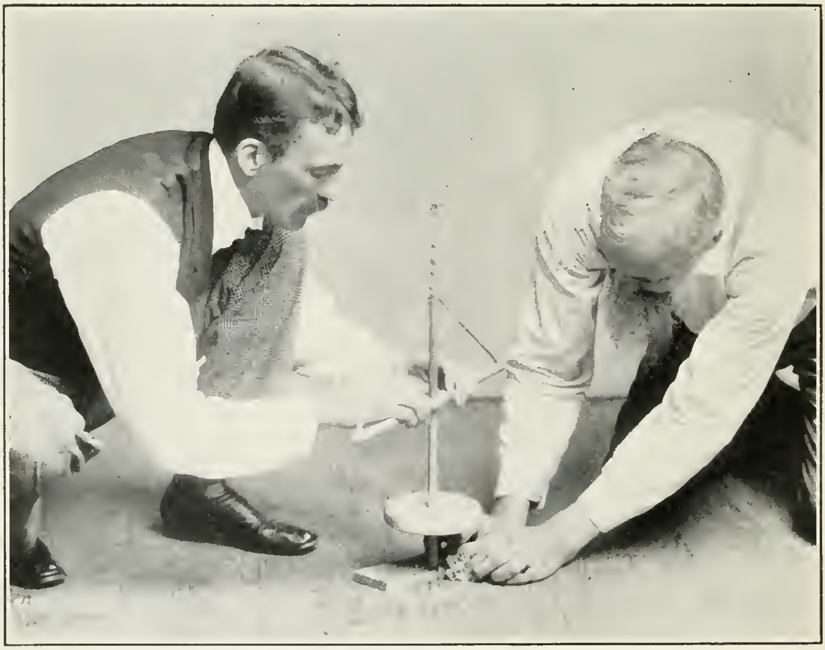


FIRE MAKING BY MEANS OF THE DRILL

Top, The mouth set bow drill, Eskimo; bottom, With the simple two-stick drill

FOR DESCRIPTION OF PLATE SEE PAGES 87 AND 95





FIRE MAKING WITH THE STRAP DRILL AND PUMP DRILL

Top, Eskimo; bottom, Iroquois Indians

FOR DESCRIPTION OF PLATE SEE PAGES 96 AND 98

pigs' heads are carved, the artist having seen two of these creatures at St. Michael's several years before.

An excellent account of the methods of fire making among the Point Barrow Eskimo is given in the Report of the Ray Expedition:

"The flint and steel is the most common method of procuring fire, using for tinder the down of the seeds of plants, impregnated with mealed powder or charcoal. Sometimes two pieces of iron pyrites are used, and we found the ancient fire drill in use among some of the old, conservative men; the drill was a shaft of spruce 18 inches long and three-fourths of an inch in diameter, the lower end terminating in a frustrum of a cone, the upper end made to fit the socket of a stone rest that is held between the teeth; a block of hard wood with a cavity in the center is used as a friction block; a small quantity of tinder is placed in the bottom of the cavity and the drill pressed down by the mouth rest and turned rapidly with a small bow like a jeweler's bow. They are anxious to obtain matches, but they are not considered a necessity, and will not buy them as a rule. Flints are an article of traffic, and are brought from Cape Lisburne and the Romanzoff Mountains, there being none indigeneous to this part of the coast. They believe that the pyrites come down from heaven in the form of meteors, and they call it firestone for that reason."[92]

Fire making among the central Eskimo is performed with the bow drill. A piece of ground willow serves for shaft and a piece of driftwood for hearth piece. Moss or the woollike hair of *Eryophorum* serves for tinder.[93]

Farther eastward, in Greenland, there is little that is different from the western Eskimo apparatus, the whole being one culture exhibiting only minor tribal and environmental phases. For a more extended study of the Eskimo fire-making apparatus see Fire-making Apparatus in the United States National Museum.[94]

CANADA AND NORTHERN UNITED STATES

In some Athapascan tribes and generally among the northern Algonquians the bow drill is employed in making fire. The apparatus is rude compared with that of the Eskimo. In only a few instances is the bow drill found south of the Canadian boundary, as among the northern Sioux and the Sac and Fox Indians, of Nebraska. From the latter a sacred fire drill used by the medicine men in procuring ritual fire was collected by Prof. Frederick Starr. The Penobscot Indians, who are also Algonquians, placed a band wheel on the spindle of the bow drill to guide the cord. The Iroquois of Canada and New York employed the pump drill for making fire in ceremonies. A specimen made from well-seasoned slippery elm was obtained by J. N. B. Hewitt among the Onondagua on the Grand River Reservation, Canada. The name is "ye yen ta ka nye tha" (one rubs wood by which). This weighted drill is described by Morgan:

---

[92] Lieut. P. H. Ray. Report of the Expedition to Point Barrow, Alaska, 1885, p. 46.

[93] Franz Boas. 6th Ann. Rept. Bur. Amer. Ethnol., 1888, p. 526, fig. 476.

[94] Ann. Rept., U. S. Nat. Mus., 1888, p. 555.

"This is an Indian invention and of great antiquity. Its rudeness may excite a smile in this day of lucifer matches, but yet the step backward to the steel and flint is about the same as from the latter to the contrivance in question. Not knowing the use of metals or of chemicals, it was the only method of creating fire known to the red man. It consisted of an upright shaft about 4 feet in length and an inch in diameter, with a small wheel set upon the lower part to give it momentum. In a notch at the top of the shaft was set a string attached to a bow about three feet in length. The lower point rested upon pieces of punk. When ready to use the string is first coiled around the shaft by turning it with the hand. The bow is then pulled downwards, thus uncoiling the string and revolving the shaft towards the left. By the momentum given to the wheel the string is again drawn up. The bow is again pulled downwards, recoiling it as before. This alternate revolution of the shaft is continued until sparks are emitted from the point, where it rests upon the piece of dry wood below. Sparks are produced in a few moments of the intensity of the friction, and ignite the punk, which speedily furnishes a fire" [95] (pl. 29, fig. 2).

The simple drill was known by the Iroquois and served for ordinary occasions.

The Tinne Indians on the Yukon River near Holy Cross Mission cut a cleft in the lower end of the drill spindle in which they press tinder. The rotation of the drill is as usual, but the tinder ignites instead of the ground-off wood meal and renders the getting of a blaze somewhat easier and surer.[96]

EASTERN AND SOUTHERN INDIANS

Roger Williams succinctly remarks that the Connecticut Indians strike fire either with stones or sticks. John Smith says of the Virginia Indians:

"Their fire they kindle presently by chafing a dry pointed stick in a hole of a little square piece of wood that firing itself will so fire mosse, leaves, or any such like dry thing that will quickly burn."[97]

The Cherokees of North Carolinia made fire with a drill of reed like an arrow. No trace of a pump drill occurs among these southern Iroquois, giving rise to the assumption that this implement is of modern introduction among the northern Iroquois, probably from their incursions to the west coast. The Creeks have retained the simple drill in ceremony, as in the Green Corn Dance. They drill out fire at the junction of logs laid in form of a square cross. The Seminoles of Florida pursue the same routine in making new fire.

---

[95] Lewis H. Morgan. League of the Iroquois, Rochester, 1851, pp. 381-382.

[96] Information by P. B. Randolph, Seattle, Wash., 1899.

[97] English Scholars Library, No. 16, Capt. J. Smith's Works, p. 58.

Among the extinct Karankawa Indians of Texas fire making is thus described by Dr. A. S. Gatschet:

"After the hut was built a fire was made. Their fire sticks they always carried with them and kept them carefully wrapped in several layers of skins tied up with thongs and made into a neat package; they were thus kept very dry, and as soon as the occasion for their use was over they were immediately wrapped up again and laid away. These sticks were two in number. One of them was held across the knees as the Indian squatted on the ground, and was about 2 feet long, made of a close-grained, brownish-yellow wood (perhaps pecan) half round in section, the flat face (held upward) about an inch across, in which were three holes about half an inch in diameter and of equal depth, the bottoms slightly concave. The three holes were equally distant apart, about 2 inches, and the first one was the same distance from the end of the stick which rested upon the right knee. In one of the holes was inserted the slightly rounded end of a twirling stick about 18 inches long, made of white, soft wood, somewhat less than the diameter of the hole, so as to turn easily. Holding the twirler (which was perfectly cylindrical) vertically between the palms of the hands, a gentle but rapid alternating rotary motion was imparted. After continuing this for about five minutes the abrasions of the softer wood caused a fine, impalpable dust to collect in the hole, from which soon issued a thin blue line of smoke; as soon as the Indian saw this he quickly withdrew his twirler with one hand while with the other he caught up and crushed a few very dry leaves, previously placed on a dry cloth close by (having been produced from their wrapping, in which they had been carefully preserved for this very purpose, to serve as tinder), and very quickly but lightly sprinkled them in and around the hole, over which both hands were then held protectingly, the head bent down and the incipient fire fanned to a blaze with the breath. As soon as the blaze had fairly caught the stick and tinder were deftly turned over upon a little pile of dry twigs and leaves, and the fire was started. Always performed by men." [98]

PLAINS

The wood friction method of fire making among the Plains Indians had become almost entirely disused before observations could be made. Generally they were found in posession of the flint and steel strike-a-light. The Comanches apparently were the last to give up the fire sticks. The art, however, was extensively revived among the Plains Indians as one of the features of the Ghost Dance religion.

---

[98] Albert Gatschet. The Karankawa Indians of Texas, Cambridge, 1891, pp. 10–11.

SOUTHWEST

The southwestern tribes were skillful in making fire with the simple fire drill. In many cases they expedited the friction by introducing sand in the cavity in the hearth. For making fire in the New Fire Ceremony the Hopi used a unique hearth made of sandstone.[99]

Cosmos Mindeleff saw a Navaho Indian on the San Juan River near Farmington, New Mexico, make in five minutes a complete fire maker's outfit from the stems of bee weed (*Cleome pungens*). The hearth or horizontal part is the stem broken off near the root, slightly chamfered on the upper and the inner side. Four slight pits on top receive the drill; these let out into gutters down the inner side. The operator put a pinch of fine sand in the cavity and piled up sand against the inner side of the hearth to receive the wood meal. The same cavity is never used twice. Among the Shoshones the gesture for fire is the rubbing of the palms.

Among the Apache-Yumas and Apache-Mohaves: "A very small fire suffices them, and they never waste wood by building large ones, even in winter or when wood is very abundant. When cold one warms himself by squatting down and wrapping his blanket around him and the fire. To kindle a fire they resorted to the fire drill before the introduction of the flint and steel and matches, but usually preserved coals in the ashes to avoid the labor of drilling. 'O-oh'te-kwa-te,' 'Make the fire blazy,' is the common expression still used even when the fire is to be kindled by means of a match. A slow torch made of dry deadwood was carried in traveling. It enabled them to make fire or smoke signals, by means of which they could communicate with their friends at pleasure, as well as to kindle a fire at their next stopping place. For a drill they use a piece of the stem of the 'o-oh kad-je,' or 'fire stick bush,' about 2 feet long and half an inch thick. They dip one end in the sand, then pressing it in a shallow depression made in a piece of dry, soft wood, such as the stalk of the yucca, which is laid on the ground and held by the foot, whirl it between the hands. In a few seconds the friction produces a small quantity of very fine charcoal, which when rolled out on some dry grass or bark fiber and given a light puff or two, bursts into a flame."[1]

NORTHWEST COAST

The northwest coast Indians used the simple fire drill and often carved the hearth in the form of mythologic beings. The apparatus is larger and more clumsy than observed elsewhere.

---

[99] Dr. J. Walter Fewkes. Journ. Amer. Folk-Lore, vol. 18, 1905 p. 194.

[1] Stephen G. Peet. Amer. Antiquairan, Chicago, 1886, vol. 8, p. 283.

PACIFIC SLOPE

The Salishan tribes retained the wooden fire sticks until comparatively recently. They also were skillful in the preservation of fire, and as a rule the fire sticks were bundled up with a braided cedar bark slow match. Paul Kane gives an account of the Chinook fire making:

"Fire is obtained by means of a small, flat piece of dry cedar, in which a small hollow is cut with a channel for the ignited charcoal to run over. This piece the Indian sits on to hold it steady, while he rapidily twirls a round stick of the same wood between the palms of his hands with the point pressed into the hollow of the flat piece. In a very short time sparks begin to fall through the channel upon finely frayed cedar bark placed underneath, which they soon ignite. There is a great knack in doing this, but those who are used to it will light a fire in a very short time. The men carry these sticks about with them, and after they have once been used they produce fire more quickly."[2]

The Quinaielt Indians of Washington made fire by drilling. "With this he lighted the end of the braided slow match of cedar bark. This was often carried for weeks thus ignited and held carefully beneath the blanket to protect it from wind and rain."[3]

Throughout California the method of making fire was uniform, one example sufficing:

"The wood most used for fire making is that of *Baccharis douglasii.* A flat stick of this, as dry as possible, is obtained and a shallow hole made in it, from which a small notch is cut to the edge of the stick. The drill, a short piece of wood with the lower end trimmed to fit the hole, is then placed in it and twirled rapidly between the palms with a downward pressure. This causes a fine dust to be ground from the stick. This dust runs out to one side through the notch, and if conditions are favorable after a time ignites, no tinder being used. But if the wood is not thoroughly dry, or if the air is moist, it is exceedingly difficult to kindle a fire by this method."[4]

WEST INDIES

Ramusio, Navagatione et viaggio, III, Venetiae, 1565 (p. 124), gives an illustration and description of the Cuban Indian method of making fire. The hearth consists of two pieces of round wood tied together at the ends. The drill works in the groove between the two sticks. Dr. H. Ling Roth remarks that this type of hearth is found nowhere else in this region.[5]

---

[2] Paul Kane's Wanderings in North America, 1859, p. 188.

[3] C. Willoughby. Smithsonian Report, 1886, p. 268.

[4] Phillip Stedmen Sparkman. Culture of the Luiseno Indians, Berkeley, Univ. of Calif. Pub., vol. 8, No. 4, 1908, p. 209.

[5] H. Ling Roth. The aborigines of Hispaniola, Journ. Anthrop Inst., vol. 16, 1886, p. 282.

The historian Oviedo (1526) figures this hearth. Ling Roth suggests that Benzoni mentions a similar method in Nicaragua.

MEXICO

There is abundant pictorial evidence on the fire drill and its method of working among the writings of the ancient Mexicans. These prove that the simple two-part drill was the form employed.[6] Other drawings in the Codex Nuttall, Peabody Museum, Cambridge, Massachusetts, show even more clearly the definite intent in fire making. Among the uncivilized tribes of Mexico up to a few years ago the fire drill was in common use.

CENTRAL AMERICA

The simple drill survives in Central America to the present. The interior and almost unvisited tribes of Panama and Darien still use the drill. The Guatuso of Costa Rica were using the drill at the time of Gabb's visit, about 1870. No pecularities of drill or hearth have been observed in Central America aside from the fact that the Costa Ricans worked the drill on a billet of wood with center groove.

SOUTH AMERICA

Many instances of the simple fire drill have been recorded from South America, but much remains. The Maeva Indians of Venezuela, who live in the Sierra Perija, use a reed for the drill, and in a hollow in the end place a piece of tinder. Two men work the drill their hands coming into play alternately. When the tinder ignites the fire maker blows through a small cut through the wall of the reed, thus fanning up the coal of fire.[7] This extraordinary and unique method indicates what may be discovered in South America when exploration by scientific men is carried further.

Im Thurn describes fire making among the Indians of British Guiana, as follows:

"Two long sticks when thoroughly dried are used in the operation. A small pit is dug on the side of one of the sticks close to one end, and a groove is cut from the pit halfway round the stick (fig. 17*a*, p. 258). One end of the second stick having been cut evenly at right angles to the length of the stick, a few inches at the same end are peeled (fig. 17*b*). A knife or flat piece of wood or stone is now placed on the ground. Across this the first stick is laid so that the pit is uppermost and immediately over the blade of the knife. The Indian then grasps this stick with the toes of one foot and then holds it steadily in one position. The second stick is held at right angles to the first, the peeled end being in the pit, the other end between the palms of the operator's hands. The left hand is held motionless while the right palm is rubbed steadily and somewhat rapidly backwards and forwards against the left (fig. 17*e*). The friction wears away the sides of the pit and enlarges it. The groove which passes half round the stick becomes an open channel through which the fragments worn away from the inside of the pit fall on to the knife or board below, where they form a small heap. At the end of a half a minute the heat within the pit, acting through the open channel, ignites the heap of dust. The wood used in the manufacture of these sticks is of different kinds. That used by the Macusis appears to be from a species of *apeiba*. That used by the Warraus is cut either from a plant called by them 'voarno' (*Gaultherea uregon* Aublet) or from the bone (midrib) of the troolis palm (*Manicario saccifera*) or from the yari-yari or lancewood tree, or from others of unknown name."[8]

---

[6] See fig. 377 from the MS. Troano in 6th Ann. Rept., Bur. Amer. Ethnol., 1888, p. 352.

[7] Theodoor De Booy. The Maeva Indians of Venezuela, Sci. Amer. Supp., 2245, Jan. 11, 1919, pp 24-26.

BRAZIL

The collections of fire tools from the Indians of Brazil show the simple apparatus prevailing in that country. In many cases no notch is cut on the edge of the hearth for the collection of the ground-off wood particles. The reason for this is that the drill and hearth are of approximately the same diameter, so that the working of the drill grinds away and cuts the side of the hearth, forming a notch. This is observed in specimens collected by Dr. Emil Hassler from the Charautes, Cayapos, Angaytes, and other Brazilian tribes.[9] There is figured in the 1891 report (vol. 2) of the Museum fur Völkerkunde of Berlin what appears to be a fire drill from the Rio Purus, Amazonas, Brazil. The hearth is a half round piece of wood with a similar piece covering it, and the two are tied together. The fire hole and slot are made near the end of the hearth and the top piece of wood is slid back to uncover the hole. This device is evidently to protect the working part of the hearth from dampness.

CHILE

The Araucanians "do not use flint for the purpose of obtaining fire, but employ, like the Kamtschatdas, two pieces of dry wood, one of which they place upon another and turn it in their hands until it takes fire, which is very soon."[10]

ARGENTINA

"The Patagonians in making fire have two pieces of wood, the one as hard as holly, the other soft as fir, the one flat, the other round. They lay the flat piece upon their knees and set the hard piece upon the other and drill it between their hands."[11]

---

[8] E. F. im Thurn. Indians of British Guiana, London, 1833, p. 257.

[9] Jarhbuch du Mittelschweizerischen Commerciellen Gesellschaft., vol. 2, 1888, pp. 114–115.

[10] Molena. History of Chili, Middletown, 1808, p. 106.

[11] Drake. World Encompassed, Hakluyt Society Publications, London, 1884, p. 50.

ETHNOGRAPHY OF THE FIRE SAW

The fire saw, like the fire plow, to which it appears to be related, is a rather circumscribed method, also centered in the East Indies, but with a more or less erratic distribution, to Australia on the one hand and to the Asiatic mainland on the other. Alfred Russell Wallace describes fire making among the Malays by this method, stating that a sharp-edged piece of bamboo is rubbed on a convex piece on which a small notch is cut. In the course of the work the convex piece is sawed through and the dust falls through on tinder placed below (pl. 30, fig. 1).[12]

D'Almeida says: "Referring to Javanese customs, before starting on our return I felt desirous to smoke a cigar in order to 'keep the cold out' but finding I had forgotten my fusee, I asked one of the men if he could give me a light. He immediately picked up a dried piece of wood, and holding it fixed on the ground, asked one of his companions to rub another across it. This being quickly done, in less than five minutes the friction caused the upright piece to burn. The man soon blew it into a flame and handed it to me."[13]

PHILIPPINES

Observations first hand on the details of the method among some Philippine tribes bring out the following: The saw is usually held in the hand and worked with a free-arm motion, as among some Negritos. The Zambales Negritos reverse the order and rub the convex piece on the saw. This reversal is often practiced among other Philippine tribes using the method, and has much to recommend it in preventing the loss of the coal of fire. The convex piece or hearth is nicked to about the depth that will be cut through at the time of greatest friction. Beneath the nick some slivers are started up, forming a support for a bit of tinder. In working, the saw becomes dark brown from friction and fibers silver off and are crowded through the slit and impinge in a mass upon the tinder. The tinder is bamboo scrapings rubbed well between the hands. For the fire saw bamboos differ in quality, a thin-walled bamboo called "buyo" being best.

The Negrito fire maker begins by scraping shavings from a bamboo post. He scoops a shallow depression in the ground and lays the bamboo hearth across it, puts shavings underneath, puts his feet, legs extended, across the ends, and saws with wonderfully quick motion. The position seems very awkward, but it is not for the Negrito. The Bagobos and Moros make fire this way.

Sometimes the bamboo hearth is laid on a round stick, which gives the operator better command of the spark.

---

[12] A. R. Wallace. The Malay Archipelago, 1890, p. 332.

[13] Wm. Barrington D'Almeida. Life in Java, vol. 2, p. 277. Quoted in R. Brough Smyth's Aborigines of Victoria, vol. 1, 1878, p. 399.

It has been told the writer that the lower-class Japanese used and still know the fire saw, but this has not been verified. It is probable that the Malay have carried the saw to distant coasts.

INDIA AND BURMA

On the mainland of Asia low and less-advanced tribes to the south and east furnish instances of the use of the fire saw.

Capt. T. H. Lewis observes of the Chittagong Hill tribes on the eastern frontier of British India:

"A groove is cut on the convex side of a piece of bamboo and a thin strip of bamboo rubbed with sand is drawn in this slit till ignited dust falls through the thin crevice left in middle of slit onto shavings."[14]

In Burma the natural bamboo is used, or a longitudinal V-shaped excavation is made in a section of branch wood, a blade is made, and the process goes on in the regular way.[15]

The Todas use the oridinary drill and the Paniyans the saw, as follows: "I recently came across a very ingenious method (pl. 1) of making fire by friction, carried out by the Paniyans, who live at Pudupadi, near the base of the Malabar hills. A portion of a bamboo stem about 1 foot in length, in which two nodes are included, is split longitudinally into two equal parts. On one half a sharp edge is cut with a knife. In the other a longitudinal slit is made through about two-thirds of its length, which is stuffed with a piece of cotton cloth. The latter is held firmly on the ground with its convex surface upwards, and the cutting edge drawn, with a sawing motion, rapidily to and fro across it by two men, until the cloth is ignited by the red-hot particles of wood in the groove cut by the sharp edge. The cloth is then blown with the lips into a blaze, and the tobacco or cooking fire can be lighted."[16]

"Throughout northwest central Queensland two methods are adopted for kindling fire, though the second to be described is perhaps commoner along the Upper Georgina.

"*a.* Twirling the stick between the flattened palms. A very dry piece of wood is selected, a little nick or concavity cut in front of the operator (fig. 244). Another long stick of the same material is taken, like it perfectly dry, and its roughly sharpened extremity placed vertically upon the nick already cut on the fixed piece. The vertical one is now twirled, rolled backwards and forwards, as rapidly as possible between the flat opened palms, the hands all the time being pressed gradually and firmly downwards. The smoke, followed by a spark or two, soon appears; with some very dry grass and a little 'blowing' this is soon fanned into a flame.

---

[14] Hill Tracts of Chittagong and the Dwellers Therein, Calcutta, 1869, p. 83.

[15] Information by Dr. R. M. Luther. See also Sci. Amer. Supp., 508, Sept. 26, 1885, p. 8107.

[16] Madras Government Museum Bulletin, vol. 4, No. 1, pp. 13-14. Madras, 1901.

"*b*. Rubbing one stick over another like a saw (fig. 245). The fixed piece of the preceding is here replaced by a piece split at its extremity, into which a wedge (*a*) is placed so as to allow of some fine dry grass, etc., (*b*) being placed and firmly clutched in the fork (*c*) so produced. Across the edges of the split a more or less deep notch (*d*) is cut, along which another piece of wood with an angular edge made to fit is rapidly rubbed forwards and backwards. The horizontal piece, what with the attrition, becomes pulverized and heated at the notch, so that sparks soon arise and catch on to the grass which thus becomes ignited.

"As a rule these fire sticks ('Pitta-Pitta toor-kin-je') are thrown aside or discarded after use. They are made only as they are wanted, and in these districts are certainly not to be seen carried about for future use. The particular timber of which they are made seems to vary, though the root portion is said to be usually requisitioned. It is said to be a kind of 'boxwood,' at other times 'lavender' wood, sometimes 'wild orange.'"[17]

The aboriginals of New South Wales saw across a billet of wood in which a longitudinal groove has been cut, and the friction thus occurs on the two margins of the hearth. J. F. Hobbs informs the writer that it is customary to tie shredded grass to the sides of the hearth and to put tinder in the groove. The method is described by John Frazer.[18]

The combination of the saw and groove in the Australian specimen is suggestive of an ancestral invention.

ETHNOGRAPHY OF THE FIRE THONG

Following the fire saw is another method in which a thong of rattan or other flexible liana is used to produce fire by friction. This subject has been monographed in a most praiseworthy piece of work by Henry Balfour.[19] Mr. Balfour traces and illustrates the method in Asia, Africa, and Europe. The eastern area extends from Assam to New Guinea; a doubtful occurrence among the Ba Kele of the Ogowe River district, West Africa; and a rather extensive use in folk practice in northern Europe. Mr. Balfour regards the rigid fire saw and the thong as closely related, the former probably the original method.

---

[17] Walter E. Roth. Ethnological Studies Among the North-West-Central Queensland Aborigines. Published by Queensland Agent General's Office, London, 1897, p. 105.

[18] The Aborigines of New South Wales, Sydney, 1892, pp. 57-58.

[19] Frictional Fire-Making With a Flexible Sawing Thong. Journ. Anthrop. Inst., vol. 44, January-June, 1914, pp. 32-64.

ETHNOGRAPHY OF THE FIRE PLOW

Making fire by rubbing the stick corresponding to the drill to and fro in a groove in the flat surface of the hearth is called the plowing method. It belongs to the group of localized fire-making arts, which will be discussed in turn. The spread of the Polynesians over a vast ocean-island area has indeed carried the plowing method far, but as this migration is comparatively recent, it is seen that the mode goes back to the origin locus in the East Indes, an area characterized by a remarkable diversity of processes in the fire-making art, some of them of limited distribution.

The rapid spread of the plowing method is suggestive of the distribution of the simple drill through ancient movements of peoples much anterior to the migrations of the Polynesians. As shown below, the plowing method occurs sporadically among peoples and in localities unconnected with the Polynesian migrations. In the present state of our knowledge a great deal as to origin must be left without explanation and with only the suggestion of independent invention, which should be advanced as a last resource.

The Samoan fire making may be taken as characteristic for the Polynesians. It must be added, however, that the rubbing stick is clasped in the interlocked fingers in a certain way, is run at a low angle at first to warm up and form the groove, and is then elevated to about 45° for the final rapidly increased friction. The method requires the most exact movements, as a movement of the rubber too far will dissipate the small mound of wood dust in which the fire rises.

"In Samoa fire was obtained by friction, and the process is still used when matches are not available. A man will take a piece of dry wood, which is placed on the ground, then another small piece is pointed and firmly grasped by the two hands. This is rubbed backwards and forwards, slowly at first, until a groove is formed in the log, when the rubbing is accelerated, until the little head of scooped-out dust at the end of the groove begins to smoke, when the operator rubs very fast indeed and the action causes the dust to ignite. This ignited matter is then placed in the middle of some inflammable material until it bursts into a flame, and with this a few leaflets of the dried coconut leaf are ignited. The exertion of rubbing the fire stick is very great. Old men are not always able to get fire, especially on damp days, and sometimes have to walk several miles to the nearest village to get a light before they can cook their food"[20] (pl. 30, fig. 2).

---

[20] George Brown. Melanesians and Polynesians: Their Life Histories Described and Compared, London, 1910, p. 129.

The Polynesians possessed excellent wood for fire making in the pariti (ante hibiscus) tiliaceum, which Dr. O. F. Cook argues was introduced in the Polynesian islands from America.[21]

The plowing method of fire making, however, has no reference to the spread of the plant, as this method is not found in America.

In Borneo the method is found among the natives of Sarawak, and a valuable description which brings out details coinciding with the process among the Polynesians is given by E. H. Lamont:

"One of the men strikes fire by means of a small branch of soft wood placed on the ground. Squatting opposite it, he holds it in its place by one of his toes, whilst some one places a foot on the opposite end for the same purpose. This piece of stick having been cut flat on the upper side, a pointed piece of harder wood, when it can be procured, is held in the right hand obliquely against the lower piece, somewhat as we hold a pen, with the left hand pressing on the fingers of the right to add force to it. It is first moved gently along the line, the motion being gradually quickened, till some brown dust is scraped up at one end of the incision thus made, and the friction being then increased in velocity, the wood finally smokes and takes fire. A dry piece of poro or huck, brought from the house where it is kept for the purpose, readily ignites when the burning dust is deposited in it, and being waved backwards and forwards is soon in a blaze."[22]

The Solomon Islanders also use the plowing method:

"A stake of dry, soft wood is selected, a convenient size being about as thick as the wrist. For convenience a few chips are sliced off in one place to make a flat surface to rest upon. The stake is then placed upon the ground in front of the operator, who sits on one end of it and holds it steady between his toes. Then with a pencil-shaped piece of harder wood, held firmly in both hands, he begins rubbing up and down upon the flat surface. A groove is formed and a dark-colored dust soon produced, which is pushed to the farther end of the groove. The dust before long begins to smoke. The pace is increased and it begins to smoulder. A piece of dry touchwood is then applied to it and quickly blown into a glow. With perfectly dry wood a native will almost certainly produce fire in less than a minute. I may add that I have rubbed till my elbows and shoulders have ached, but have never been able to produce more than smoke."[23]

The Tasmanians used the ordinary simple fire drill, but are occasionally said to have used the plow method. It appears that the art of preservation of fire was more important with them than that of making it anew with sticks.[24]

---

[21] O. F. and R. C. Cook. The Maho or Mahagua as a Trans-Pacific Plant, Journ. Washington Acad. Sci., vol. 7, Mar. 19, 1918, pp. 153–170.

[22] Wild Life Among the Pacific Islanders, London, 1867, p. 156.

[23] C. M. Woodford. A Naturalist Among the Head-Hunters, New York, 1890. See also The Savage South Seas, by Norman Hardy and E. W. Elkington, London, 1907, p. 132.

Prof. Frederick Starr clearly describes the plowing method in the Congo:

"The Batua we saw here were little, but well built. We measured two of them, both below the 1,500 millimeter limit; they are the two rubbing fire in our picture, and are the first in the following table. These little people regularly make fire by friction of wood. The implements are a section of branch about an inch in diameter, 6 or 8 inches long, split lengthwise, and a stick of the same wood, about the same length, bluntly pointed at the ends; both are somewhat charred and black with smoke. The section is laid upon the ground so as to slope slightly; a man with a leaf folded to protect his foot stands upon the lower end of this stick to hold it firmly; a second man, kneeling, holding the rubbing stick with both hands, sets the point in a longitudinal groove freshly cut in the lower piece of wood, applies considerable pressure and rubs briskly to and fro, rapidly deepening and wearing the groove; smoke appears almost immediately, and a spark soon glows in the fine dust that is rubbed out. Ndombe's Batua also make fire by friction, but by the more common method of whirling an upright stick between the palms, the lower bluntly pointed end resting with pressure in a notch cut in a lower stick laid on the ground. From 30 seconds to a minute is ample time for the production of fire. In both regions the larger neighbors of the Batua look with contempt upon the making of fire by friction, as suited only to the despised Batua."[25]

M. Maurice Reygasse has discovered a fire plow in use by Berbers in Aures near the oasis of Negrine, 150 kilometers south of Tebessa, Algeria. The apparatus is described and figured by A. de Mortillet,[26] who compares it with similar apparatus used elsewhere. The material is the fruit stem of the date palm. The Berbers use sand to increase friction when making fire with the plow. M. de Mortillet also sayes that Frederick Starr has observed the fire plow among the Batuas of Belgian Congo, a dwarfish people with brown skin.

ETHNOGRAPHY OF THE FIRE PISTON

"When a body has its density increased its capacity for heat is diminished. The rapid reduction of air to one-fifth of its volume evolves heat sufficient to inflame tinder."[27]

---

[24] H. Ling Roth, assisted by Marion E. Butler and Jas. B. Walker. The Aborigines of Tasmania. Halifax, England, 1889, pp. 183-184.

[25] Frederick Starr. Ethnographic Notes from the Congo Free State, Proc. Davenport Acad. Sci., vol. 12, 1909, pp. 96-222.

[26] Bull. et Mem. Soc. d'Anthropologie de Paris, ser. 7, vol. 1, 1920, Nos. 4, 5, 6.

[27] Haswell. Engineer's Pocket Book, ed. 4, 1855, p. 198.

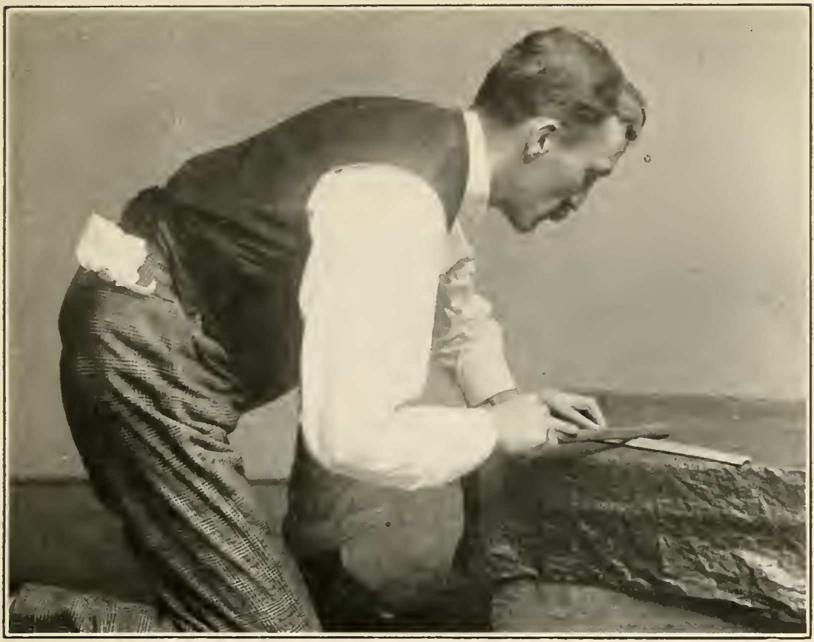
This is the principle involved in the operation of the aerophore, pyrophorus, fire syringe, or fire piston, as it has been variously called. The device for lighting tinder is a tube closed at one end with a smooth and accurate bore fitted with a plunger packed at the end to insure complete compression. At the end of the plunger was a small cavity for holding the tinder. This instrument was a scientific curiosity sometimes used by lecturers to demonstrate the heat effects of air compression. It was sometimes, though rarely, used by individuals as a personal strike-a-light. The instrument as made by white men was manifestly unsatisfactory and uncertain in its performance. This is because the white man did not know the details of its proper construction. The same phenomena occur when a tyro endeavors to make and work a fire drill. There are, therefore, good grounds for suspecting that the European modes of the fire syringe were amateurish approximations of the effective implements of native use and manufacture in the East, a knowledge of which had filtered back through the agency of travelers. In any case, if the fire syringe was discovered or rediscovered in the course of experimental or practical work in mechanics, it had not arrived at the perfection of the Malay apparatus. There are no valid reasons why the fire syringe is not a native invention. Its technology among the various tribes practicing its use give it a native phase. It is of a higher grade of invention than the fire drill, but not more difficult of conception and execution. The entire stock of the genius of man is not centered in the advanced nations. Theories of the origin of the fire syringe have been vitiated by the idea that it is an apparatus of scientific rather than native technology.

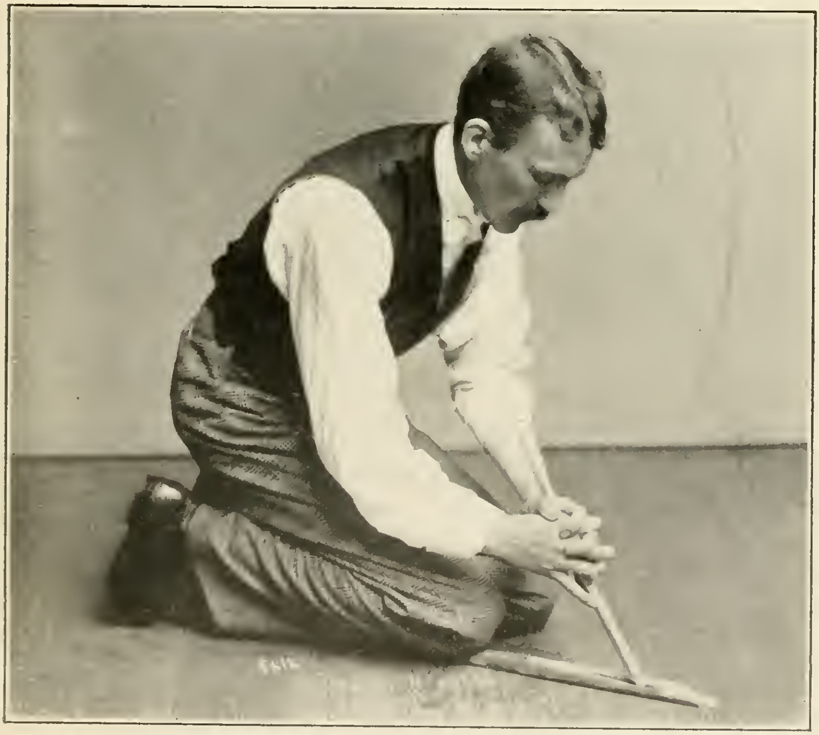
Henry Balfour, who has monographed the fire syringe, states that it "extends sporadically over a wide range from northern Burma and Siam through the Malay Peninsula and the Malayan Archipelago to its eastern limits in the islands of Luzon and Mindanao in the Philippines."[28] Mr. Balfour shows that the instruments occur in Burma, French Indo-China, Malay Peninsula, Sumatra, Sarawak, Borneo, British North Borneo, Java, Flores, and the Philippine Islands.

Of the eight fire syringes in the United States National Museum from widely separated localities, four have a bore of one-fourth of an inch, one of five-sixteenths and two of three-eighths inch. One may conclude on the showing that one-fourth inch is the effective bore. The depth varies from 1¾ inches (two specimens) to 4½ inches. On this showing the depth is not important. Horn and hardwoods are the materials of the specimens above mentioned (pl. 31, figs. 1–5).

---

[28] The Fire Piston. Anthrop. Essays Presented to Edward Burnett Tylor in Honour of His 75th Birthday, Oct. 2, 1907.

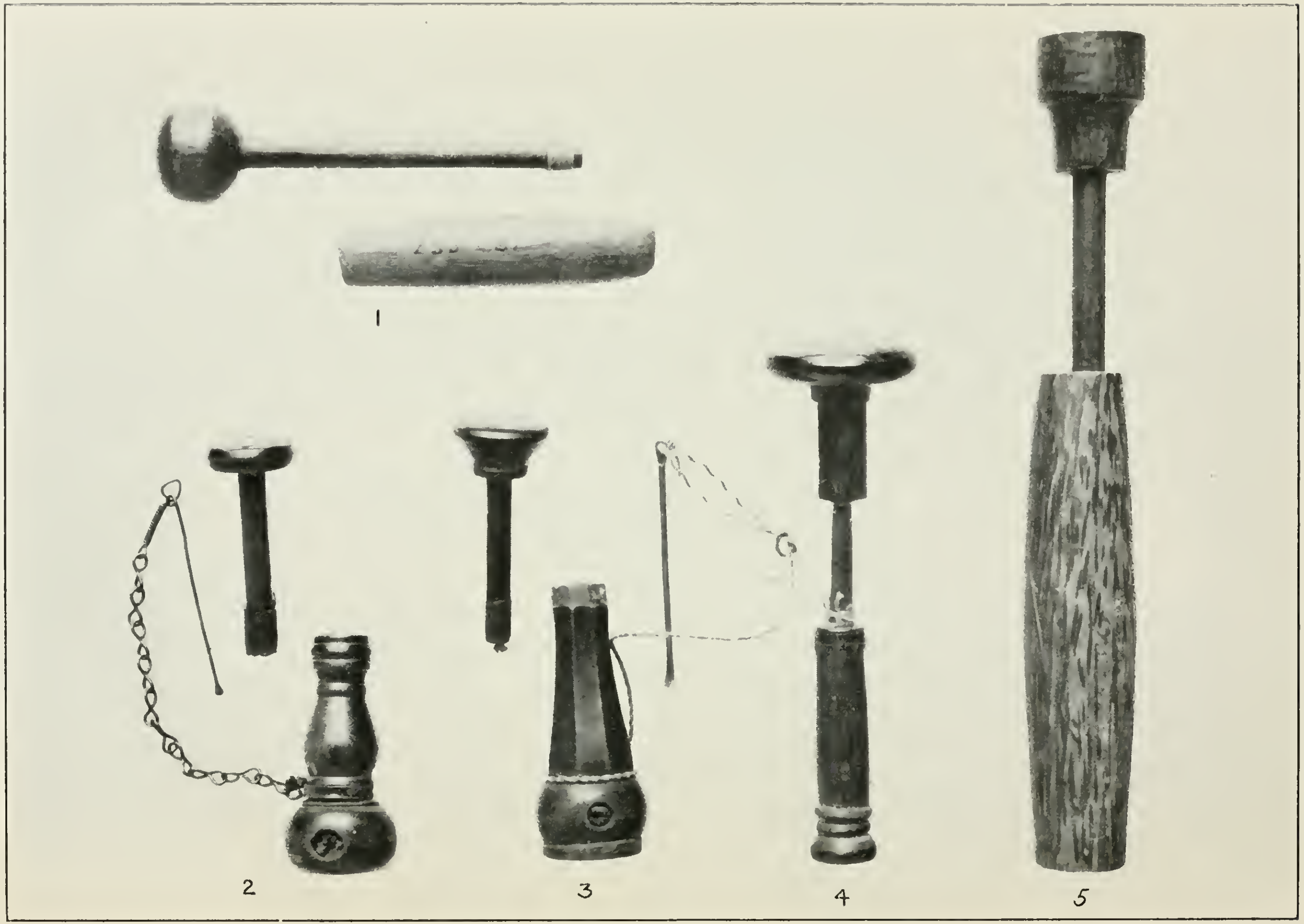




Fire Making with the Fire Saw and Plow

Top, Eastern Asia; bottom, Polynesia

For description of plate see page 107



Fire Pistons for Igniting Tinder by Air Compression

1, Siam; 2, Lower Siam; 3, Philippine Islands; 4, Philippine Islands; 5, Java

For description of plate see page 110

THE STRIKE-A-LIGHT

The strike-a-light of pyrites and flint and pyrites has an ancient history of which a few threads may be traced. The precedence of the art of wood friction and percussion of minerals is a subject of discussion and inquiry, but there appears little probability of coming at the facts. It is clear that the so-called steel could only be an introduction of the Iron Age. Malleable iron does not produce sparks with flint, so that the discovery of iron as a product of smelting iron ore had no effects in superseding the earlier pyrites, which appear to have persisted until steel became available. Flint struck upon flint yields no sparks, but there is produced an evanescent luminescence expanding in the substance of the stone and rapidly fading away. Whatever the explanation of this phenomenon, it is not important in the art of fire making. The sparks struck from pyrites are dull red and inflame only quick tinder. The spark struck with flint and steel results from a minute fragment of metal heated to incandescence by the friction. By friction is meant the sudden transfer of a disproportionate force to a small mass, with the resultant heat effects. It is also thought that not all sparks from flint are thus explained, but that a chemical combination of iron and silica is produced in some of the flashing meteoric sparks.

The most ancient form of strike-a-light is that employing flint and pyrites. This dates certainly to Neolithic times, and doubtfully earlier. The tendency of pyrites to decompose or disintegrate often renders it difficult to locate this method in sites under exploration.

ETHNOGRAPHY OF FLINT AND PYRITES

America.—The combination of a lump of pyrites and a flint scraper, which is so common that they are always associated, as noted in flint and steel, does not indicate a necessity for the flint. Two lumps of pyrites struck together are adequate. The reason for the flint scraper is that it gives more precision and lessens the danger of breaking the pyrites, which easily occurs when two masses are struck together. Neolithic scrapers of a certain type are therefore not necessarily implements of fire making with pyrites.

Harris states that the Virginia Indians made fire with flint and pyrites.[29]

Of the Algonkians Le Jeune says:

"Concerning their fusil they do not do as we. They have for a match the skin of an eagle's thigh with the down on, which takes fire easily; they strike two iron stones together as we use a strike-a-light with a bit of iron or steel; in place of allumettes they use a little bit of timber (it is of punky wood very dry, which burns easily and incessantly until totally consumed). Having made fire they put it into pulverised cedar bark and blow softly until the bark flames."[30]

---

[29] Voyage and Travels, vol. 1, London, 1705, pp. 816, 1602.

Thomas Morton, in his New England Canaan, refers to the Indian use of two stones for striking fire. T. G. B. Lloyd says that the Beothuc ignited the down of the blue jay by sparks struck from two pieces of iron pyrites. In their graves "Two 'fire stones' or nodules of iron pyrites lay at its head, such as were used by the red Indians for producing fire by striking two pieces of the substance together."[31]

C. C. Willoughby, in the exploration of several burial places in Maine, found worked pyrites in the excavations.[32]

The pyrites strike-a-light was in rather general use among the eastern and central Eskimo, and were found side by side with the implements for wood friction. There is a pyrites mine on Boothia Felix at Elizabeth Harbor, and there was trade in the mineral for potstone from Wager River.[33]

Kane saw the Eskimo of Anoatok making fire with quartz and pyrites:

"On our arrival at the hut an Esquimaux was striking a fire from two stones, one a plain piece of angular milky quartz, held in the right hand, the other apparently an oxide of iron. He struck them together after the true tinder-box fashion, throwing a scanty supply of sparks on a tinder composed of the silky down of the willow catkins (*Salix lanata*), which he held on a lump of dried moss."[34]

"For the purpose of obtaining fire the Eskimo use two lumps of common iron pyrites, from which sparks are struck into a little leathern case containing moss well dried and rubbed between the hands. If this tinder does not readily catch, a small quantity of the white floss of the seed of the ground willow is laid above the moss. As soon as the fire has caught it is gently blown until the fire has spread an inch around, when the pointed end of a piece of oiled wick being applied, it soon bursts into a flame, the whole process occupying two or three minutes."[35]

Among the Eskimo of Point Barrow, Alaska, the use of flint and pyrites is described on page 97.

To the east of Point Barrow the Eskimo at Cape Bathurst and Herschel Island used flint and pyrites.[36]

The slave and Dogrib Indians of Canada "kindle fire by striking together a piece of white or yellow pyrites and a flint stone over a piece of touchwood. They are universally provided with a small bag containing these materials, so that they are in a continual state of preparation to produce fire."[37]

---

[30] Le Jeune. Relation de la Nouvelle France, en l'Annee 1634, vol. 1, p. 25. Quebec, 1858.

[31] Journ. Anthrop. Inst., vol. 4, 1874, p. 33. Pyrites also found in Eskimo graves at Hudson Strait. (Information by F. F. Payne.)

[32] Prehistoric Burial Places in Maine, Arch. and Ethnol. Papers, Peabody Museum, vol. 1, 1896, No. 6.

[33] Information by Dr. Franz Boas.

[34] Dr. E. Kent Kane. Arctic Explorations, vol. 1, pp. 379-380. Philadelphia, 1856.

[35] Parry's Expedition, p. 504.

[36] Walter Hough. An Eskimo Strike-a-light from Cape Bathurst, Proc. U. S. Nat. Mus., 1888, p. 181.

Hearne, in journeying to the northern ocean in 1772, discovered a solitary female of the Dogrib Indians who had been seven months in the forests without seeing a human being." To support herself she had built a hut, and with much ingenuity snared rabbits and partridges, etc. To procure fire she picked up two sulphurous stones from which by long friction and hard knockings she drew sparks, and used touchwood for tinder. Though acquainted, as she must have been, with the process of obtaining fire from wood, she probably found herself from want of practice unable successfully to perform it."[38]

"The Han Kutchin buried with the dead a flint fastened to a stick, a stone to strike it on to make fire, and a piece of the fungus that grows on a birch tree for tinder, with some touchwood also."[39]

So far as has yet been ascertained, in the vast stretch between the Canadian and Eastern Indians noted and some tribes living in the southernmost parts of South America there was no use of flint and pyrites by any Indians. In Tierra del Fuego, however, the method is found and has been thus described:

"Fire is maintained with great care wherever these savages go, by carrying about a piece of burning wood. Should it accidently become extinguished they procure it again from sparks produced by striking two stones against one another. The sparks so produced are received into tinder made from the underdown of birds, well dried, or fine dry moss, and then by fanning the lighted tinder in the air a flame is produced and the fire again kindled."[40]

Another description gives more details:

"His method of procuring fire is unique. Wherever he goes he carries along a bit of 'mundic' or iron pyrites, which is found upon the mountain sides all over Tierra del Fuego. This mundic when struck by a pebble will produce sparks. The sparks are caught upon a tinder of dried moss or the punk of a dead log, and when ignited the tinder is placed within a ball of dried grass, and this being rapidly whirled in circles soon sets the grass in a blaze. Then it is only necessary to communicate the blaze to a bundle of sticks and the work is complete. But this is a good deal of trouble, and that the lazy Fuegian does not like. Therefore he is extremely careful of his fire, lighting one on shore at nightfall from that in the boat, and vice versa in the morning."[41]

---

[37] Alexander Mackenzie. Voyages from Montreal Through the North American Continent, 1801, p. 36.

[38] E. H. Knight. The World a Workshop, p. 55.

[39] Strachan Jones. Smith. Inst. Rept., 1866, p. 326.

[40] J. G. Garson. Inhabitants of Tierra del Fuego, Journ. Anthrop. Inst., London, vol. 15, 1885, p. 145.

[41] Fannie B. Ward. Washington Star, Jan. 16, 1892.

Weddal says that the Fuegians barter pyrites with the Tehuelches, which would indicate that the latter tribe also struck fire by this method.[42] The Tehuelches are also known to have used flint and steel.

ETHNOGRAPHY OF THE FLINT AND STEEL STRIKE-A-LIGHT

There is a general consensus in the use of the term firestone for flint. The Assyrian "aban isati" has this meaning.[43] It may be pointed out, however, that the name for the flint does not indicate the other part of the strike-a-light was steel, as it is known that the earliest type employed pyrites. While the wider distribution of the flint and steel strike-a-light clearly depends upon the production of steel in sufficient quantity, it is not argued that an ancient and limited use of steel for fire making could not have existed in the early Iron Age. There appears to be no evidence of such use older than among the Romans of the later Iron Age, the first notice in literature being by Lucretius, 95–51 B. C. The Assyrians of 800 B. C. were proficient iron workers, as were the Hindus of an early date, but no employment of steel in fire making is noted. Similarly, in Egypt, where the Iron Age has its oldest date, no strike-a-light has been found. The oldest surviving steel for the strike-a-light, if the identification is correct, was found in the pile dwellings of Ueberlinger See and dates from the late Iron Age.[44]

As stated previously, the flint and steel strike-a-light owes its usefulness to that metal and not to iron, which is loosely considered as equivalent to steel. Soft iron is not suitable for the "steel," and likewise meteoric iron, tested on the Canyon Diablo, Arizona, and Durango, Mexico, irons through the courtesy of Dr. George P. Merrill. The flint and steel apparatus, therefore, must be discussed in regard to the manufacture of the metal which has superseded iron. This is a difficult problem on account of the scarcity and questionableness of the data. It is thought that steel made from iron by the cementation process originated in India. This process consists of heating iron in a closed vessel in presence of animal matter, such as skin and horn, the effect being to form a layer of steel upon the iron. The common term for the process is casehardening, and knives so treated were called case knives. If the treatment was continued the whole mass of the iron was converted into steel. It is not probable that steel became abundant enough for use in striking fire till comparatively late in the Iron Age. Weapons consumed most of the steel made, and its use for tools was probably mainly limited to chisels and files. The Romans employed steel for these purposes probably as early as the third century B. C. It is seen on examination of a large series of strike-a-lights that the file has been an important agency in furnishing the necessary metal in all corners of the earth. From a general review of the subject it may be concluded that in earlier times the flint and steel was quite limited, and that its wider adoption was due to trade and intercourse.

---

[42] Voyage Toward the South Pole, p. 167.

[43] F. Delitzsch. Assyrian Grammer, New York, 1889, p. 57.

[44] Ferdinand Keller. Swiss Lake Dwellings, 1878, fig. 29, pl. 28.

America.—The strike-a-light in the Western Hemisphere is an example of the recent introduction of flint and steel. Explorers, traders, and settlers brought it from Europe, and the older methods rapidly passed out of use except in isolated places and for cult purposes. Matches still further displaced the native method and also the flint and steel, so that there is no tribe in North America relying upon wood friction to produce common fire.

The Eskimo of Alaska, on account of their isolation, had little opportunity to acquire steels, and there are few instances of its use among these tribes before the great gold rush which introduced matches as a substitute for the fire drill. The Tinne and Northwest coast tribes had become familiar with flint and steel, the first tribe through commerce with the Hudson Bay Company and the second by way of the sea. The Algonkians to the east had the flint and steel early from the French explorers, traders, and missionaries, and under similar influences the Plains tribes discarded fire sticks and took up this new method and rapidly made it their own. The tribes of the East also early received the flint and steel from the English and French, and discarded the old methods with the same facility as the stone arrowhead. A similar state of affairs is seen among the southern tribes, where French influence was prominent. In the vast extent of Texas steels were not easily obtained, and some tribes possessed them while others continued the use of fire sticks. The Pueblo region, which was the first touched by white men, proved most conservative and never adopted the flint and steel. Here only recently fire sticks were supplanted by matches. As a rule, in California and on the Pacific coast generally the flint and steel was not used, and fire sticks remained in vogue among the Indians later in this region than in any other part of North America.

In Mexico among the more modified peoples the flint and steel was common, and among the wild tribes it was rarely found. Here the apparatus shows its Spanish origin.

In Central and South America the steel was found mainly in the possession of the people of European antecedents, and was rarely employed by the uncivilized tribes, and then by those living on the routes of commerce.

In the New World the commerce in steels and flints of European origin was important. The great bulk of flints for guns, pistols, and strike-a-lights came from England, where an industry continued from Neolithic times supplied the world with a professional product made of the best material by the "flint knappers" of Brandon. On account of the demand for flints this industry is still carried on.

Steels came to America through trade in goods of the English, French, and Spanish principally. They were also brought in personally by immigrants from various countries.

Steels were of different sizes, adapted to use in the family tinder box, for carrying on the person by travelers and hunters, and sometimes in neat cases for carrying in the pocket. Three well-marked types are found in America; the straight bar with curved handle, of English make, usually found in the sheet-iron tinder boxes common in New England and called a "flourish"; a straight bar with curved handles at either end bent over and meeting at the middle, the ends bent into an incurved hook, Russian; curved bar with handles bent over and brought down to the bar, forming two finger loops, Spanish and French; strip of steel bent to form the letter C, United States trade; and strip of steel in form of letter O, Holland. Most of the specimens found in America are made from files. Aside from the types mentioned there are pieces of files and nondescript examples made by local smiths. In Mexico there is sometimes encountered a steel of V shape, the extremities of the arms bent inward into a volute and the base chisel shape, as in a screw driver. This is evidently a survival of a combination tool, part of the equipment of soldiers using the old flintlock and perhaps matchlock gun. A similar combination was made in England stamped "Jukes, Coulson and Co., No. XLI," date unknown. It is in the form of an oval loop.

Europe.—The forms of steel of European derivation found in America may be taken as representative of the geographical area under consideration. The steel typical of Europe is a loop shaped much like the oval drop handles used on furniture. Less common is the variant in which the prongs are bent down to form two loops, as in the Spanish examples. Some of these are specimens of artistic ironwork. The loop form has had almost world-wide distribution.

Asia.—European forms of steels have the widest distribution in Asia and crop up in the regions most accessible to commerce. In northern Asia, especially Mongolia and China, the flint and steel has been the object of more inventive thought than elsewhere. The curved steel is mounted in the lower margin of a pouch with flap in which the flint and tinder are carried. The pouch has a handle to which a cord is secured for fastening the apparatus to the belt. Such pouches from Mongolia are often incrusted with gold and silver, set with turquoise and coral. The apparatus is a complete unit as definitely adapted to its purpose as a watch. Aside from the great area coming under Chinese trade, influence, and customs, the North Asiatic strike-a-light is simple as in other parts.

Nordenskijold says: "They light fire by flint and steel of a form of Siberian or Russ-Siberian origin. The flint is a beautiful chalcedony or agate. As tinder are used partly the woolly hair of various animals, partly dry fragments of different kinds of plants. The steel and a large number of pieces of flint are kept in a skin pouch suspended from the neck. Within this pouch there is a smaller one containing the tinder. It is thus kept warm by the heat of the body and protected from wet by its double envelope. Along with it the men often carry on their persons a sort of match of white, well dried, and crushed willows, which are plaited together and placed in even rolls. This match burns slowly, evenly, and well." [45]

The Buriats use the Chinese pouch form of strike-a-light:

"The Buriat implements for striking fire used to be preferred to European, and commanded a high price among the Russians. They are made of plates of the best-tempered steel, from 4 to 6 inches long, stitched to a bag for holding the tinder, the bag being of red leather and tastefully ornamented with silver and steel bangles. The English and Swedish matches have now driven them out of the Russian market." [46]

The northern Chinese strike-a-light consists of a steel of C shape, a bit of worked flint, and a bamboo tube to hold yellow paper tinder. [47] Another form consists of a curved steel with a perforation for a cord by which it is secured to a knit bag containing the tinder and flints. These strike-a-lights are purely local Chinese forms. The type used pretty generally in China is a small leather pouch with a flap having the steel fastened in the lower edge, and is much less ornate than Mongolian specimens.

The Japanese strike-a-light, such as is kept in the house, consists of a blade of steel with two sharpened prongs driven into a block of wood, a flint, and a bundle of splint matches tipped with sulphur, all kept in an oblong box, one section having a wooden damper for the tinder. The pocket form consists of a little bag containing the necessary parts. A specimen collected among the Aino of Hokkaido Island has a curved steel blade secured to a cylindrical piece of wood with iron bands. A ring in the wooden part serves to attach a cord bag and carved wood tinder box. The specimen is evidently Japanese. The Aino strike-a-light has a steel resembling an irregularly shaped lancehead with a hole near one edge for the passage of a cord to which is attached a tinder box made of a section of a stem with bark like a cherry tree.

The Siamese strike-a--light seen has an oblong thick steel with rounded ends, probably worked from a file. The steel is kept in a bamboo tube containing the tinder placed in a bamboo box. A steel from the Punjab, India, is a straight bar with a curved handle welded to it. The Koords of Bhutan use the C-shaped European form of steel, and a similar specimen was collected at Baghdad.

---

[45] Baron N. A. E. Nodenskijold. Voyage of the Vega, vol. 2, London, 1881, pp. 120-121.

[46] Henry Lansdell. Through Siberia, Boston, 1882, pp. 368-369.

[47] Information by W. W. Rockhill.

The strike-a-light does not appear in native African collections, and its introduction from outside is quite limited. Around the Mediterranean coast of North Africa this device partakes of its particular European origin. From the Anbanala Tribe, valley of the River Faraony, comes a steel with a broad oblong striking surface turned over at one end and formed into a tang for holding the implements. The steel, flint, and tinder, are contained in a well-carved wooden box.

The above review of the ethnography of the flint and steel strike-a-light on account of the scarcity of the material is necessarily incomplete. The available material used, however, proves that this method of fire making has spread in recent times from the centers of civilization. Dr. Edward B. Tylor's remarks on the subject are illuminating:

"The flint and steel may have come into use at any time after the beginning of the Iron Age, but history fails to tell us the date of its introduction in Greece, Rome, China, and most other districts of the Old World. In modern times it has made its way with iron into many new places, though it has not always been able to supersede the fire sticks at once; sometimes, it seems, from a difficulty in getting flints. For instance, it was necessary in Sumatra to import the flints from abroad, and thus they did not come immediately into general use among the natives; and there may perhaps be a similar reason for the fire drill having held its ground to this day among some of the iron-using races of southern Africa."[48]

Mention here may be made of the tinder pistol, in which the flintlock mechanism as in an ordinary pistol struck the spark into a tinder pan. Sometimes the apparatus was inclosed in an egg-shaped metal box for carrying in the pocket. A seventeenth century pocket lamp used in ecclesiastical duties had flint, steel, and tinder in a compartment.

The wheel tinder box, an improvement on the tinder pistol, had a steel wheel balanced over the tinder pan in a tin box. The wheel was turned by a cord over the axle impinging on a flint. The miner's flint or spark lamp was a similar wheel driven with a crank instead of a cord. It was used several score years ago in England.

A curiosity in the application of flint and steel was a flintlock operated by clockwork for firing an explosive at a fixed time. It is attributed to Robert Fulton, who is said to have invented the device for defense of New York Harbor by torpedo against the British in the War of 1812.

---

[48] E. B. Tylor. Early History of Mankind, Boston, 1878, p. 248.

ETHNOGRAPHY OF THE BAMBOO STRIKE-A-LIGHT

One of the most surprising examples of aboriginal technology connected with fire making is the bamboo strike-a-light.

"For striking a light the men carry in their waist belt a small bamboo prettily carved, in which some tinder and a bit of porcelain are kept out of the rain. By holding the tinder and the piece of broken plate in the right hand, and striking it sharp on the side of the bamboo, the tinder is lighted."[49]

Were it not for the scientific standing of those who have published their observations on this method, the matter might be dismissed as a traveler's tale. The flint and steel strike-a-light is easily understood as a scientific and widely distributed way of making fire, but the use of wood instead of steel is anomalous, to say the least.

The great naturalist, Alfred Russell Wallace, in the well-known work, The Malay Archipelago, describes the bamboo strike-a-light as follows: "The Ternate people use bamboo in another way. They strike its flinty surface with a bit of broken china and produce a spark, which they catch on some kind of tinder" (p. 332).

In various other parts of Malaysia this fire-making device is found, and in the Philippines it is seen among the Battaks of Palawan and the Malays of Balaback.

The device is found in Cochin China.

The Alfuros of the Waigiou Islands, northwest of New Guinea, had the bamboo and pottery apparatus.

"Their method of obtaining fire was new to all of us, the spark being struck from the hard, siliceous exterior of the bamboo and a fragment of pottery, which latter article they had probably obtained from the coast tribe."[50]

These references indicate that the method had a considerable range, possibly into the Congo region in West Africa. Its distribution has not been worked out, but it is hoped that Henry Balfour will take up the subject. The writer finds no difficulty in making fire by this method. Observations on the specimens in the United States National Museum show that a particular kind of bamboo having a hispid siliceous coating is used. The Filipinos call this bamboo buyo. Smooth bamboos are not serviceable. The tinder must be quick, and the scurf down of a species of Caryota palm (determined by Kew Gardens) or the like is used.

LENS AND MIRROR

It is perhaps of minor consequence whether the lens and mirror were used to make fire, as they could never have been of much importance in the fire-making art as utilitarian devices. Fire by the lens and mirror in such historical advices in the classics must be mainly referred to cult. The direct capturing of fire from the sun must appeal to those who desired pure fire with which to worship.

---

[49] D. D. Daly. Explorations in North Borneo, Proc. Roy. Geog. Soc., January, 1888.

[50] F. H. H. Guillemard. Cruise of the Marchesa to Kamschatka and New Guinea. Second Edition, New York, 1889, p. 371.

The lens necessarily subdates the period of quartz working. Lenses so far recovered from archeological sites would be assigned to the Roman period. There is no doubt that the lens was used for lighting the sacred fire in Rome. Such use is mentioned by Aristophanes and by Plutarch. [51]

Glass mirrors were made by the Romans to such an extent that they displaced the metal mirrors of earlier technology, or rather combined metal and glass in a new way. The focusing of the sun's rays by curved mirror surfaces was known to the Romans and Greeks; witness the burning of the fleet at Syracuse by Archimedes. This feat has been questioned, but modern research shows that the conditions of the problem confronting Archimedes could be satisfied by mirrors set in the narrow confines of a harbor magnified in story. The Romans employed also the mirror to light the sacrifice.

The use of the mirror for fire making elsewhere, as in Mexico and Peru, has been affirmed by writers whose observations were affected by a knowledge of the classics. There is not a shred of archeological evidence that the Mexicans or Peruvians knew the properties of regularly curved mirrors, although numerous plane mirrors of obsidian and pyrites have been unearthed in Mexico.

In Europe even after the crystal lens had become available, if not common, it had limited use as a fire-making device, and may be compared in this respect with the sundial.

ETHNOGRAPHY OF TINDER

The inflammable substance called tinder is an indispensable adjunct to all strike-a-lights, but it is not required with the drill, although frequently used in wood friction to augment the coal secured by drilling. The selection and preparation of tinder requires considerable knowledge and skill. The human forethought incorporated in the triad of the strike-a-light marks it not as a simple invention but an assemblage of remarkable inventions.

The variety of tinder is very great. For the most part vegetal substances are employed.

America.—The Eskimo of Point Barrow, Alaska, use the catkins of the Arctic willow for tinder. This is the usual tinder among the Bering Strait Eskimo. The Eskimo of Cumberland Gulf, Canada, make tinder of the down of the "Arctic cotton" plant, *Eriophorum calothrix.*

---

[51] Morris Hickey Morgan. De Ignis Elicienda Modis Apud Antiquos. Harvard Studies in Classical Philology, vol. 1, Boston, 1890. Berthold Laufer. Optical Lenses. T'oungh-pao, ser. 2, vol. 16, No. 2 May, 1915.

Hearne gives a detailed account of the tinder of the Athapascans of western Canada:

"Westward to procure birch rind for making two canoes, some of the fungus that grows on the outside of the birch tree, which is used by all the Indians in those parts for tinder. There are two sorts of these funguses which grow on the birch tree; one is hard, the useful part of which much resembles rhubarb, the other is soft and smooth like velvet on the outside, and when laid on hot ashes for some time and well beaten between two stones is something like spunk. The former is called by the northern Indians jolt-thee, and is known all over the country bordering on Hudson's Bay by the name of pesogan, it being so called by the southern Indians. The latter is only used by the northern tribes, and is called by them 'Claite-ad-dee.' The Indians, both northern and southern, have found by experience that by boiling the pesogan in water for a considerable time the texture is so much improved that when thoroughly dried some part of it will be nearly as soft as spunge. Some of those funguses are as large as a man's head; the outside, which is very hard and black, and much indented with deep cracks, being of no use, is always chopped off with a hatchet. Besides the two sorts of touchwood already mentioned, there is another kind of it in those parts that I think is infinitely preferable to either. This is found in old decayed poplars and lies in flakes of various sizes and thickness; some is not thicker than shamoy leather, others are as thick as a shoe sole. This like the fungus of the birch tree, is always moist when taken from tree, but when dry it is very soft and flexible and takes fire readily from the spark of a steel; but it is much improved by being kept dry in a bag that has contained gunpowder. It is rather surprising that the Indians, whose mode of life I have just been describing, have never acquired the method of making fire by friction, like the Esquimaux."[52]

In the region of the giant cedar the Indians often make tinder from the finely shredded bark. The Tlinkit of Alaska prepared tinder from a polyporus fungus. In the east the Iroquois use a species of fungus which grows on the maple, or a kind that is considered inferior growing on the birch.[53]

The Sioux Indians collected a fungus which grows as a membrane in the hollow of a decayed tree. This makes the best tinder.[54]

The Apache Indians of Arizona use tinder made from two varieties of dried fungi, one growing on trees and the other the common puffball. The Southern Plains Indians struck sparks into soft, decayed wood. In Mexico little packets of thin sheets of fungus steeped in saltpeter are sold as tinder. In Cuba dried bundles of corn tassels served as tinder.

---

[52] Samuel Hearne. Journey, etc., London, 1795, p. 278.

[53] Sir Daniel Wilson. Prehistoric Man, vol. 1, London, 1865, p. 132.

[54] Information by Francis La Flesche.

Bates states in regard to fire making on the Amazon at Murucupi: "Fire making on the Amazon at Murucupi * * * first scraped fire shavings from the midrib of a Bacaba palm leaf, struck a light in his old bamboo tinder box with a piece of an old file and flint, the tinder being a feltlike soft substance manufactured by an ant (*Polyrachis bispinousus*). By gentle blowing the shavings ignited.[55]

In British Guiana the light wood of Hernandia guianensis was used for tinder.

"Fire is maintained by the Fuegians wherever they go by carrying about a piece of burning wood. Should it accidentally become extinguished, they procure it again from sparks produced by striking two stones one against another. The sparks are received into tinder made from the underdown of birds, well dried, or fine dry moss, and then by fanning the lighted tinder in the air, a flame is produced. At night the fire is fed to the fullest possible extent, and around it, with their bodies almost in the ashes, lie the wretched inmates. When the family is numerous they dispose themselves in a line, one pressing against the other, and the last one covering his back with a rug of guanaco or sealskin."[56]

The Beothucs of Newfoundland are also said to have used down of the blue jay.[57]

The Tehuelches of Patagonia used tinder of a fungus growing at the base of the Cordilleras.[58]

Europe.—The common tinder for domestic use in England and introduced into the United States in colonial times was made by burning linen and smothering it before it was consumed. The round tinder box was supplied with a damper for this purpose. The resulting tinder was very quick. "Matches" consisting of splints of pine, the ends dipped with sulphur, served as an intermediary between the glowing tinder and a flame. In Scotland tinder was made from the inner bark of the birch, and also from a fungus growing on the oak. Amadou, a name given to tinder made from fungi, was commonly sold in Europe for use with the strike-a-light. It was called German tinder, and was prepared from *Polyporus igniarius* and *P. fomentarius* by cutting the masses into slices and boiling them in a solution of saltpeter. Another European tinder chemically prepared was touch paper, or paper dipped in saltpeter and dried. Gunpowder moistened and rubbed into tinder improved it, and powdered charcoal made tinder quicker.

---

[55] Naturalist on the River Amazons, 1910, p. 22.

[56] Garson. Jour. Anth. Inst., London, vol. 15, 1886, p. 145.

[57] T. G. B. Lloyd. Journ. Anthrop. Inst., vol. 5, 1875, p. 225.

[58] Lieutenant Musters. Journ. Anthrop. Inst., vol. 1, 1871, p. 199.

Connected with tinder is the meche of the matchlock gun, a cord or fuse of nitrified cotton flax, paper, or bark, used before the application of the principle of the strike-a-light to firearms. This fuse is an essential part of the pocket strike-a-light still occasionally used in Europe by those affecting old customs, or practically by the people to defeat the high excise on matches.

Asia.—At Cachar, Assam, the scurf from a species of Caryota was used for tinder. In various parts also fungus tinder was employed. At Leh, Ladak, tinder was made from scrapings from the stems and leaves of the *Echinops cornigerus* De Candolle. These identifications were made at the Royal Botanical Gardens, Kew, England. Information by W. W. Rockhill is to the effect that in Tibet tinder is made from flowers similar to edelweiss prepared by rubbing dry after mixing a powder and water. In Japan a number of kinds of tinder were carefully prepared and quite effective. The flowers of the *Artemisia moxa* made good tinder. The specific name of the plant is derived from its use as a cautery in moxa. Another tinder, called "hokutchi," was commonly used with the flint and steel. It is of cotton impregnated with gunpowder. A similar kind made of shredded cloth and gray in color is sold in packets. Another Japanese tinder is the soft brown scurf down of some plant. A common tinder used in China is of shredded paper, probably nitrified.

Through lack of data little can be said of tinder in other geographic areas. In New Guinea the bark of the Melalenca is employed as tinder.[59]

Among the Hottentots the decayed mimosa and willow, as also the aloe, are used for tinder and answer the purpose well.[60]

MATCHES

To transfer the glowing bit of tinder into a flame requires more forethought and skill than is usually recognized. The coal secured by wood friction is placed in dry, inflammable material and given an extra supply of oxygen by gentle blowing or by waving in the air. Between the coal and a flame there is many a slip. With the coal derived from striking flint and steel on tinder a similar process would be required, and to bridge this gap a number of inventions have been made, culminating in the match. The Chinese accomplish this with a roll of paper like a "spill," which, if lighted, smoulders until blown upon dexterously, when it bursts into flame. These spills are of great use to smokers of the water pipe, who constantly refill the small bowl and relight the pipe. The name "*pe-i-hu*" indicates the sound made by blowing up the lighter. It requires much skill to blow the lighter into a flame. In the West, where chemistry was more and more coming into domestic life, it was customary to dip the ends of pine splints into melted sulphur. These "spunks" were easily ignited from the tinder set on fire by the flint and steel. These simple lighters, in almost universal use up to 1825, were evidently the starting point for the inventions which gave to the world the friction match. The first chemical match, which was part of an apparatus called the "Instantaneous light box," invented by Chancel, came out in 1805 or 1806. It was a small tin box containing a bottle filled with asbestos saturated with sulphuric acid and a supply of prepared matches. These were splints of wood about 2 inches long, which were dipped into sulphur and then into a mixture of potassium chlorate 6 parts, powdered loaf sugar 2 parts, powdered gum arabic 1 part, colored with some material and made into a paste with water. They were easily lighted by dipping them into the acid, but were not regarded as much of a success on account of the weakening of the acid by absorption of moisture from the air. Victor Hugo in Les Miserables makes the gamin Gavaroche in his retreat in the Elephant use an apparatus called "Fumade's fire producer," apparently a French invention and sold at first for £1 sterling a box. This consisted of a bottle of phosphorus and small sticks tipped with sulphur. When one of the sticks was dipped in the phosphorus it inflamed on being brought out into the air. It was used in Paris in 1832.

---

[59] E. Beardman. Journ. Anthrop. Inst., vol 14, 1884, p. 470.

[60] Archibald Campbell's Travels, London, 1818, p. 159.

The first friction matches were made by dipping splints in melted sulphur, then in a liquid of potassium chlorate and antimony sulphide and gum water. They were ignited by drawing them through a folded piece of sandpaper. This was the original lucifer, invented by John Walker, Stockton upon Tees, in 1827:

"The inventor of the lucifer match certainly deserves well of his country, and his country would probably before now have recognized its indebtedness in this matter of striking a light if there had not been more than one claimant to the honor of being the first matchmaker. It has at last been proved by documentary evidence that the first maker of matches was John Walker, a chemist of Stockton-on-Tees, who sold the first box for one shilling and twopence in April, 1827. The matches soon became popular, and the people came from long distances to buy them. The poor of the town were employed to split the wood for these early matches, which were invariably dipped in the phosphorus compound by the inventor himself. This worthy man was pressed to form a company to work the invention and to patent it; but he refused, on the score that he had enough for his simple wants and that he would put no obstacles in the way of a thing which promised to be a boon to the public. John Walker died in 1859 and a movement is now on foot to raise a monument to his memory." [61]

---

[61] Chambers's Journal vol. 11, p. 827.

Credit for the first primitive match is claimed in several European countries. This is the history of many important inventions at the time of their inception, when the minds of numerous investigators are independently focussed on the same problem. In reality John Walker worked for the common good and not for personal or racial credit. Nevertheless, a record of sales entered in a notebook of the date shows that John Walker sold matches of his invention and make in 1827.[62]

Phosphorus, which was discovered by Brand about 1673, was experimented with in the line of fire producing with little success. One of the earliest methods for its utilization was to rub a bit of it between two folds of coarse paper and to allow the spark of fire thus produced to fall upon a "spunk." These clumsy devices led to nothing of importance, and phosphorus was not used in a practical match until 1833.

The real key to the match was the discovery by Bertholet, the great French chemist, about 1800, of "the principle of the oxidation of combustible bodies by chlorates in the presence of strong acids." This was the idea adopted in Chancel's instantaneous light box mentioned. About 1830 the first phosphorus or parlor match, in which red phosphorus with binding and coloring material was used, appeared commercially in Austria and Germany. In 1855 safety matches were invented in Sweden.

Several interesting devices for fire making appeared in the formative period of the match. In 1780 Volta demonstrated an apparatus in which hydrogen gas was ignited by the electric spark. An apparatus in which hydrogen was ignited by directing a jet of the gas against spongy platinum came into use in 1823.

"Before lucifer matches came fully into use a chemical apparatus known in Germany as Dobereiner was used to a considerable extent for obtaining a light. It consists of a cylindrical glass jar 4 inches in diameter, 6 inches high, with a flat trap cover, from the center of which hangs down a glass bell 2 inches in diameter and 4½ inches long, reaching down almost to the bottom of the jar. Inside this bell are suspended half a dozen square pieces of zinc with holes in them, so that they can be threaded on an iron wire. On top of the cover is a jet and stop cock opening out of the bell, and in front of it a small chamber containing a bit of spongy platina. The jar is filled with dilute sulphuric acid, which acting on the zinc, generates hydrogen gas. When the gas is allowed to play upon the platina it renders it incandescent and a light can be obtained by applying a spill."[63]

---

[62] Sci. Amer., Apr. 20, 1895, p. 261.

[63] J. R. Allen. Proc. Roy. Soc. Antiq. Scot., 1879–80. p. 253.

In 1830 "Prometheans" were invented in London. This consisted of a spill of waxed paper, the end dipped in a mass of potassium chlorate and sugar, and within the tube was inclosed a minute glass globule of sulphuric acid. On breaking the globule the acid lighted the match.

FIRE GODS

In taking up the subject of fire in its religious aspect it is realized there is opened an extensive, complicated, and difficult field. It is only possible to present the leading features and in general to note the extraneous form, without attempting the impossibility of reaching the inner spirit. The cult features may be apparent, but the creed is hidden.

According to Dr. Edward B. Tylor, "the real and absolute worship of fire falls into two great divisions; the first belonging rather to fetishism, the second to polytheism proper, and the two apparently representing an earlier and later stage of theological ideas. The first is the rude, barbarous adoration of the actual flame which he watches writhing, devouring, roaring like a wild animal; the second belongs to an advanced generalization that any individual fire is a manifestation of one general elemental being, the fire god." [64]

There is an extensive pantheon of fire gods. Of the ancient gods who were powerful in the religions of antiquity mention may be made of Amen of Egypt, affiliated with the sun; Baal, the Chaldean and Phoenician fire god; Gibil, the Assyrian fire god; Agni, of the Aryan Hindus; and so forth. Little has survived as to the ceremonials performed in favor of these ancient gods of fire. In Mexico, however, when the first Europeans reached that country a fire cult complete in all its elaborate details was flourishing. Sahagun, who busied himself with gathering up the threads of the fast-disappearing old order, preserves valuable data on this cult. He says that the fire god Xiuhtecutli, "lord of comets," was also called Lxcocauhqui, "yellow face," Cuecaltzin, "flame," and Ueue teotl, "the ancient god," whom everyone claimed as a father. The images of this god represented a naked man with the base of the figure painted with "ulli," a black resin (caoutchone), and a red stone thrust through his lower lip. He had on the head a crown of paper painted with various designs in colors, surmounted with sprays of green plumes in form of a flame, and he was crowned with balls of feathers that hung at the sides of the head toward (vers) the ears. The ears bore rings incrusted with turquoise mosaic. On the back was a tunic of yellow feathers representing a dragon's head, accompanied with small sea shells. Rattles were attached to the ankles. In the left hand he held a buckler surmounted with five large green stones, called Chalchiuitl, placed in the form of a cross over a gold plaque that covered almost all its surface. In the right hand he carried a sort of scepter having a round plaque of gold pierced with a hole in the center and surmounted by two globes of different sizes, the smaller supporting a pointed object. They called this scepter Tlachieloni, which means lorgnette, because by means of this object one could hide his face, yet seeing through the center of the plaque of gold.[65]

---

[64] Primitive Culture, vol. 2, 1871, p. 277.

The following prayer to the god of fire, written down in Nahuatl by Sahagun, is valuable for its literary quality and the insight it gives into the philosophy and theology of the Mexicans:

"You, Lord, who are the father and mother of gods and the most ancient divinity, know that comes here your vassal, your slave; weeping, he approaches with great sadness; he comes plunged in grief, because he recognizes that he is plunged in error, having slipped over some wicked sins and some grave delinquencies which merit death; he comes, on account of this, very heavy and oppressed. Our god of pity, who art the sustainer and defender of all, receive in penitence and relieve in his anguish your serf and vassal."[66]

The Hopi Pueblo Indians represent in several ceremonies a being painted black and spotted with red, a fearsome being called Shulawitsi, the fire cachina. This being has not the status of a fire god as the Mexican fire god, since the Mexican cult was more advanced than the Hopi. It is more than possible that Shulawitsi is the Mexican Xiuhtecutli incorporated into the Hopi pantheon. Shulawitsi as prototype of Xiuhtecutli can not be advanced with confidence, the tendency being to regard these as cognate deities in the same racial stock.

The Navaho Hastsezini, god of fire, appears to be affiliated with the Hopi fire god. He is also black, and his offering is a cigarette.[67]

Less-developed fire gods are found among most of the American Indian tribes. The Manitous of the Algonkians are examples of this class. Still farther down in the scale appear to be the mythological beings who jealouly kept fire away from man, furnishing the material for the numerous theft episodes in the fire myths. Others may be seen in the beings who gave fire to man.

Some insight may be gained of Aino ideas of the fire god from the following, care being taken to observe the mingling of two theologies:

"The deity who is generally looked upon as standing next in order to the goddess of the sun is the goddess of fire. She is conceived of as being both useful and awful; useful, inasmuch as she warms the body, heals it when ill, and cooks its food; awful, inasmuch as she is a special witness to note the acts and words of men and women. It is she who will appear either for or against us at the Judgment Day. She will present the great Judge of all with a perfect picture of every word and action of each individual human being, and there can be no avoiding her. Thus every person will be rewarded or punished hereafter according to the representations of the goddess of fire. We can, therefore, easily understand the great importance the Ainu attach to fire worship. But here again we must be careful not to think that it is the fire itself which is worshipped. Fire is not worshipped, but a goddess who is supposed to dwell in the fire, and whose vehicle the fire is supposed to be. This is a subtle distinction, but is nevertheless true."[68]

---

[65] Bernardino de Sahagun, Book 1, ch. 13, London, 1830, pp. 29-30

[66] Idem, p. 24.

[67] Washington Matthews. The Treatment of Ailing Gods, Journ. Amer Folk-Lore, vol 52, 1901, pp. 20-23.

"The Ainu always pray to the goddess of fire in cases of distress. Thus, when a person is taken ill, his friend or relative, the chief of the village gets a new piece of willow wood fresh from the forest, and sitting down before the fire peels off the outer rind and shaves the stick into an inao. When it is finished he places it in the corner of the hearth near the fire, and asks the fire goddess, who is supposed to be a great purifier from disease, to look kindly upon the sick one. He next addresses her by the name of 'messenger' and requests her to go to the Creator and ask Him kindly to accept the inao he has just made, to hear his prayers, and to allow her, 'the fire goddess,' to heal the sick one. The idea seems to be that the Creator is too great a personage to condescend to do the healing himself."[69]

FIRE WORSHIP

Investigators who seek to collect information about esoteric things from uncivilized peoples know how difficult it is to arrive at the heart of rites and beliefs. So much harder it is for those whose observations must be superficial, but who must be relied on as furnishing the only material available. Knowing the difficulties which scientific men experience in describing Indian ceremonies, and how far even they sometimes come of the truth and how patiently they must hunt for the one who knows and who will tell, the student almost despairs of finding material upon which to base his deductions. The changing aspects of religions from century to century introduce new facets to belief. In view of these considerations the Parsees are not fire worshippers, but worship fire as a symbol of God, as they now inform us. Whether the Parsee were always monotheists ought not be difficult to say, but by using the final results of a superior philosophy, a wooden image of the lower tribes is such a symbol with a similar explanation.

In any case the Parsee worship fire, as is shown by their rites and attitude. So much is known concerning the Parsee fire cult that it may be taken as a good example of a completed later phase which furnishes some explanation of the scattered myriad observances of uncivilized peoples in fire worship.

---

[68] Rev. John Bachelor. The Ainu of Japan. New York, 1903, p. 277.

[69] Idem, p. 97.

"The Parsee are commonly called fire worshippers, as if that element were itself, like Agni in Vedic times, an object of superstitious regard; but this they specially disclaim, affirming that fire is only the symbol of God, whom alone they worship. Their sacred rites are in great part performed before the consecrated fire in the fire temples, of which there are 7 of the highest grade in India, called Atash-Behrams, and more than 100 of the second grade, called Atash-Adarans. The fire in these temples is fed day and night with sandalwood and is never allowed to go out; in fact it is said that the Parsee fugitives from India brought fire with them, which has been kept up continuously ever since. When a fire is desired for some new temple it must be specially prepared. A perforated metallic tray containing chips and dust of sandalwood is held over a temple fire until they are ignited. Then a second fire is procured from this in the same manner, and so on for nine times, until by successive siftings out of the earthy and baser qualities of the flame a pure and ethereal element is produced. Fire coming directly from heaven, that is, by lightning, is most highly esteemed. The household fire is only in a less degree sacred, and should never be extinguished. In the morning it is saluted by each member of the family with a handful of sandalwood. These fire ceremonies are designed, say the more intelligent Parsees, to keep ever present to the mind the duty of preserving the thoughts, words, and deeds from all impurity in sight of the One Supreme Deity, and are in no sense idolatrous. While the priest tends the fire his mouth is covered with a muslin veil that no defilement from his breath may reach the flame. He chants prayers at stated intervals, sitting cross-legged before the flame and holding the *barsom-beresma,* in the Avesta, or bundle of twigs in his left hand. The prayers are in the old language of the Parsee scriptures, written in the Gujerati character, and are seldom understood by those who repeat them. The chief offering of the Parsees is the homa juice, corresponding to the soma of the Hindus. This should be used twice a day, both in private houses and in the fire temples."[70]

With the worship of fire is combined the idea of perpetual fire. The Parsee housed this fire in stately temples. Humboldt, describing the precincts of one of these temples, says: "Around the sacred precincts were planted cypress trees whose forms suggested flames."[71]

The cypress was said to have been reared in paradise.

A Parsee fire temple at Surocehain near Baku made the first use recorded of natural gas.

---

[70] John Avery. American Antiquarian, vol. 9, March, 1887, p. 119.

[71] Cosmos, p. 101.

"In the beginning of the seventh century, when the religion of Mohammed became dominant in Persia, many Parsees had to leave the country; of these a part settled in the region of Baku, and tradition tells that the eternal fire over which their shrine was built was discovered in the following manner: A well having become suddenly dry, the owner threw down a piece of lighted tow in order to see the bottom, when immediately the mouth burst into a pale amber flame, which continued to burn for ages until five years ago (1880). From a very small structure, occupied by one or two priests, the temple grew in course of time to a building of considerable size, which exists to-day in a state of good preservation. As is usual in the East, it is in the form of a hollow square, composed of about 20 chambers, all built in solid masonry, which look into the courtyard. These chambers are all fitted with raised platforms of stone, serving as beds, and various recesses in the wall form receptacles for the property of pilgrims.

"Over the entrance door is a small house occupied probably by the priests and serving as a lookout over the plain. In the middle of the courtyard stands a square kiosk, carried on four columns, which are continued for a few feet above the domed roof. These columns are hollow and communicate with the gas supply, so that they may be lighted at the top. Below the dome is the altar, where the gas is burnt day and night.

"For various reasons the prestige of the temple fell away. The priests as they died were not replaced, and five years ago the last one disappeared, no one knows whither. The fires are now extinct, the alter is cold, and weeds and wild flowers cover the courtyard or sprout from the walls. A petroleum refining company, whose premises adjoin the temple, protects it from destruction and admits visitors on application. Thus for a few years longer the interesting relic of a past age will be preserved from its ultimate fate of being swallowed up and lost in a vast manufacturing district. It is not difficult to imagine what would befall it if left to the marauders of the country. The massive wooden door has at least a dozen bullet holes through it, fired from the outside."[72]

The fire worship of the Parsee is an offshoot or of cognate derivation with Vedism. It appears that Zoroaster (about 660) was the agent in crystallizing the prevalent practice of fire and nature worship among the rude tribes of the Persian highlands, and sought to found on it the higher conceptions which would constitute a new religion. While the course of Zoroastrianism through the centuries did not develop the barbarianism of the Hindu cults, it had not the seeds of a great religion and has almost disappeared.

---

[72] Sassoon Lectures. No. III, Petroleum, by J. Wallace, Bombay, p. 16.

An account of Zoroastrianism and a description of the cult apparatus of the Parsee has been prepared by Dr. I. M. Casanowicz, of the United States National Museum.[73]

The Yezidis of Mesopotamia near Mosul have a well-developed light and fire worship which seems to be allied to that of the Parsee. Layard says: "They have more in common with the Sabaeans than with any other sect * * * reverence the sun * * * have a temple and oxen dedicated to the sun * * * kiss the object on which its first beams fall. For fire, as symbolical, they have nearly the same reverence; they never spit into it, but frequently pass their hands through the flame; kiss them and rub them over their right eyebrow, or sometimes over the whole face."[74]

He also says of the priests, who are occupants of the tomb of Sheikh Adi, founder of the sect:

"As servants of Sheikh Adi they are the guardians of his tomb, keep up the holy fires and bring provisions and fuel to those who dwell within its precincts and to pilgrims of distinction."[75]

PRIESTS

The fire cult as a feature of the religion of the ancient civilized nations shows a detailed organization indicating a long maturity, and even that at one time it may have been a major religion.

Traces of the cult are observed in all religions, but it is another question whether it represents sporadic inclusions or developments from an earlier cult submerged by varied additions.

The fire cult necessitated orders of fire priests. The Atharvans were Vedic fire priests identical with the Persian soshyantes. Zoroaster was a fire priest. The prytanes of ancient Rome were also of this class. They were conservers of the tribal fire, fed at public expense, and became magistrates in which were combined the powers of captain, priest, and king. Other fire priests are discovered in the ancient civilizations of the Near East. In effect those persons in all stages of culture who offer to the fire are priests. The medicine man, head of the family, or other responsible person made the offering (see Sacrifice).

There are, therefore, grades of fire priests from the lowest culture to the highest.

The Hopi Indians had an order of fire priests at one time, no doubt having a ritual, now lost, and when first observed by Dr. J. W. Fewkes, dealing with fire magic, healing, and jugglery. The priests were called Yayawympkia. Other Pueblos had similiar orders. In Mexico the whole fabric was well defined.

---

[73] Parsee Religeous Ceremonial Objects. Proc. U. S. Nat. Mus., vol. 61, 1922, pp. 1-16.

[74] Henry Layard. Ninevah, New York, 1859, p. 191.

[75] Idem, p. 195.

Among several tribes of the American Indians whose customs have been studied a functionary whose office is fire keeper has been noted. This official, who may be termed a priest and who also may be connected with the ancient duty of fire preservation, is best known among the Iroquois.

This office seems to be the same as that of the pipe keepers, an office pretty generally found among the Indians.[76]

ALTARS

As seen from previous instances, any fire may serve as a fire altar at times and be ministered to by an extempore priest. The greater fanes are surrounded with all the pomp with which man environs sacred things. Among the Haida Indians of British Columbia the fire is the way between men and gods, so that anything to be sent is thrown in the fire and burnt.[77]

Among the Nahuas of Mexico stone altars, the top slab sometimes hollowed, stood before the chapels, and on them fires were kept burning perpetually, it being considered a great calamity if the fire went out. Six hundred of these braziers, from 2 to 5 feet high, were installed around the great temple of Mexico.[78]

Copal burnt in braziers was a favorite offering made by the Aztec tribes to their gods.[79]

The incense burner may be regarded as a special altar (see Incense). The Kokona Tanguts had a fire altar among the obos which were around the lake. "In another place there was a cylindrical stone in which it was customary to make fires." [80]

OFFERINGS

The subject of fire offerings may draw upon innumerable instances showing beliefs and customs regarding fire. The greater number of these refer to offerings of food and drink to the supposed spirits of the fire, and to various other materials which are burnt for the promotion of agriculture, etc. Frequently the smoke is the offering and the fire is only the means of making the offering. A curious instance of this was observed in the dance for restoring health practiced by the Wyandots of the Sandusky River, Ohio, in 1806:

"At first Longhouse the prophet, rose, took a bunch of herbs that to appearance had been bruised and dried, and cast it upon the fire. He stood in a fixed position until the smoke had nearly all ascended; he then sat on the ground, smoked his pipe, sat still, then rose and made a short speech, which Mr. Atkins supposed to tell what the Great Spirit had told them to do." There followed singing and rattling of a tortoise-shell rattle.[81]

---

[76] James Mooney. 14th (Pt. 2) Ann. Rept., Bur. Amer. Ethnol., 1896, p. 960.

[77] Information by J. R. Swanton.

[78] H. H. Bancroft, vol. 2, 1875, p. 584.

[79] John G. Bourke. Amer. Anthrop., January, 1893. p. 67.

[80] Sven Hedin. Through Asia, vol 1, 1899, p. 1148.

The hunter of the Cherokee Indians offers to the fire a piece of meat cut from the tongue of the deer. He rubs his breast also with ashes from his camp fire before lying down to sleep, in order that fire may bring dreams and omens of success.[82]

Garces observed among the Shoshones of Tulare County, California, a particular fire offering:

"A little while after the service began the wife of the chief arose, took a basket of seed (chico) and scattered it over the Santo Cristo I wore on my breast; the same did other women, and they even threw some of this seed (semilla) on the fire in order that there should be a bright light."[83]

Hodge says in a note that "the present Pueblos before eating frequently throw a small quantity of food into the fire."

"In former days the Kansa used to remove the hearts of slain foes and put them in the fire as a sacrifice to the four winds."[84]

The offering of victims to fire by the ancient Mexicans is well known.

A fire sacrifice in the Shortlands, Solomon Islands, is described by Brown:

"In building a large house for Gorai, 'devil men,' the natives took pieces of the cooked *cuscus* and other food and threw them with prayer into a fire. This fire was required to die out of itself. The ceremony is called *sisifela*."[85]

To rouse or revive fertility, producing crops and food, "the expert would convey the *Kapu* (the immaterial, imaginary emblem of the material emblematical post) to the ahi taitai, a specially generated *tapu* fire. At this fire certain ritual was recited over the *Kapu* in order to make it restore the fertility or productiveness of the land, forest."[86]

SACRIFICE

This form of fire worship often presents strange phases representing varieties of belief sometimes difficult to classify. A number of these sacrifices are expiatory. At a certain season of the year the Koreans secured images of straw rudely shaped to represent human figures, male and female. Small coins were placed in them and they were thrown away at a prescribed place, torn to pieces by searchers for the money, and afterward burnt. Humboldt states that straw effigies were burnt at the Pascua pageant at Cartagena, Cuba.[87]

---

[81] Diary of Quintus F. Atkins. Western Reserve Society, Tract 50, 1891, p. 112

[82] James Mooney. 7th Ann. Rept., Bur. Amer. Ethnol., 1891, pp. 370, 372, 392.

[83] Elliott Coues. On the Trail of a Spanish Pioneer, 1894, p. 276.

[84] J. Owen Dorsey. 11th Ann. Rept., Bur. Amer. Ethnol., 1894, p. 380.

[85] George Brown. Melanesians and Polynesians, 1910, pp. 203–204.

[86] Elsdon Best. Spiritual and Mental Concepts of the Moari. Dominion Museum Monograph No. 2, Wellington, New Zealand, 1922, p. 19.

In Tibet "there is also the sacrifice done by fire, and many things are thrown into it. This is a long rite, and it is celebrated with songs and music and much solemnity, but not often."[88]

Bonvalot speaks of encamping in Tibet "upon fallow ground close to a fine elm with an obo beside it. Under the shade of the tree is a sort of altar, analogous to the *ara* of the Romans, in the hollow part of which we can see ashes and charcoal, odoriferous plants being burnt upon it in honor of the divinity. Resting against the trunk of the tree is a whole bundle of sticks with rags and slabs of wood with prayers written on them, while on the branches are a number of skins of lambs and goats in an advanced state of decomposition, which have been hung there as votive offerings."[89]

The use of fire in the skull cult among the Dyaks of the Baram River, Sarawak, Borneo, was observed by Dr. A. C. Haddon.

"The skulls were decorated with strips of palm leaf, fed with bits of pork and bamboo cups of spirit (barak); beneath them a fire is always kept burning; all this to keep the skull fed, cheered, and warm to insure good crops and other blessings."[90]

INCENSE

While smoke customs are general among the uncivilized American tribes, definite incense rites connected with a more or less involved religious system are only found among the civilized. Beginning with the Pueblo Indians of the southwestern United States, the custom reaches a great expansion in Mexico, Central America, Peru, and other civilized peoples of South America.

CLASSIFICATION OF CENSERS[91]

I. Communal or General.

Stationary

(*a*) Tribals, society, and family fireplaces, fire boxes, and fire alters,

Several ideas are involved in this division, such as preservation and renewal of fire for the health and well-being of the larger and smaller social unit or religious organizations, as well as the beings themselves; sacrifice to fire by various oblations, with the idea of feeding, attracting, appeasing, or beseeching the unseen beings. These and other unformulated acts associated with fire have been observed throughout the world among peoples of different degrees of culture.

(*b*) Great stone braziers, generally of hourglass shape, erected on masonry bases before temples or shrines. (Mexico.)

---

[87] Macgilivray's Humboldt, p. 268.

[88] Horace della Penna. in Narrative of the Mission of George Boyle, etc., pp. 336-337. London, 1876. Edited by C. R. Markhan.

[89] G Bonvalot. Across Thibet, New York, 1892, p. 34.

[90] A. C. Haddon, 1901, p. 332.

[91] Extracted from Censers and Incense of Mexico and Central America, Proc. U. S. Nat. Mus., vol. 42, 1912, p, 109.

Stone basins borne by animal or human figures placed at shrines or sacred locations. (Chiapas, Yucatan, Mexico; Costa Rica; Honduras; and Guatemala.)

Circular stones on short pediments or caryatides; "altars" of shrines, in temples. (Yucatan and Honduras.)

(*c*) Large pottery vessels of hourglass shape ornamented with masks, bands, knots, knobs, and spurs, and painted in colors. Placed as the stone braziers before temples or at shrines. Essentially Nahuatl. (Nahuatl, Mexico; Guatemala; Costa Rica.)

II. Special.

1. Portable

(*a*) Braziers of small size used in dwellings. Of various forms. (Mexico.)

(*b*) Tripod censers consisting of a bowl mounted on three splayed feet, preserving in general the hourglass form. Set on the ground. (Southern Mexico; Costa Rica.)

(*c*) Bowl censers bearing a mask and other rudiments of human or animal forms, as in the monolithic braziers. (See I, *b*.) (Chiapas and Yucatan, Mexico; Guatemala; Costa Rica.)

2. Gesture Censers

(*a*) Flaring bowls with rudimentary handle and spurs representing other feet of tripod. (Oaxaca, Mexico.)

(*b*) Openwork pottery tripod vessel, one leg of which is extended to form a handle. Rattle feet. (Zapotec area, southern Mexico.)

(*c*) Spoon with truncated handle. Ventilation holes in bowl. Rude. (Zapotec area, southern Mexico.)

Small spoons with conventional animal handle. (Southern Mexico; Costa Rica.)

(*d*) Incense ladle consisting of a bowl ventilated with openwork pattern and having a long, hollow handle containing rattles and terminating in a serpent or other head. Nahuatl form. (Central Mexico.)

(*e*) Tublar pipes for incensing the esoteric beings and cardinal points. Pipes in general cult uses. (Ancient and modern Pueblos and other Indians, also northern Mexico and other Mexican localities.)

(*f*) Cigarettes. (Mexico and ancient Pueblos.)

3. Swinging Censers

(*a*) Censers introduced from Europe. Accultural. (Chiapas specimen.)

III. Communal or General.

Stationary

(*a*) The great masonry braziers located before shrines about the teocallis, and at various other sacrificial spots where perpetual fires were maintained and offerings consumed were not strictly incense burners, though so treated at times. Usually upon them living victims were immolated, and it was the custom to throw into the brazier fire the ashes and unconsumed incense from the portable censers, together with the paraphernalia and offerings which have been employed in ceremonies. The brazier was the source from which live coals were taken to ignite the incense in the hand censers.

The offering of incense is almost universal. Tribes which have reached a stage where recurrent rites are observed, and where ceremonials have attained some complexity, make use of this feature of the fire cult, and below this grade of culture individual or family acts of worship often show the employment of incense or fire offerings.

While fire may be primary in regard to the origin of the idea of incense, it became secondary as applied to advancing cults; that is, offerings were not confined to the communal house or camp fire, but were made on special hearths or in special apparatus. Nevertheless, no incense was so offered that was not ignited from a sacred fire; that is, one carefully prepared to insure purity, and secured from the ancient wood drill, from lightning, lens, mirror, or other consecrated or supernatural source. New fire is kindled by the Lacandones of Chiapas by wood friction for use in consecrating censers and igniting copal burned at that time.

The new fire is thought by the Lacandones to be efficacious in healing sickness, the soot collection on palm leaves being the common method, but a stone heated in the fire and used to warm water renders the latter a panacea for fever.

The phenomena which accompany combustion are so familiar that the man of our times passes over the marvel of smoke, flame, and ashes without analysis or comment. To the man of a certain stage of advancement we may suppose that the wonder of the birth, life, and death of fire was a vivid reality; it is evident from a survey of the widespread remnants of the fire cult that the steps of this mysterious physical manifestation impressed his mind, determined an attitude (creed), and predicted a course of action (cult) in consonance with the observed facts of fire action.

The lore of smoke is extensive, embracing individual acts and collective acts relating to fumigations both sacred and profane. The ideas relative to the purification, healing, scaring of demons, removing of evil influences, etc., effected by smoke have been in the minds of votaries of fire worship in diverse countries and periods, and it is even probable that fumigations alluded to by Shakespeare in Much Ado About Nothing, where a perfumer is ordered to smoke a musty room, or when in The Taming of The Shrew the command is given "And burn sweet wood to make the lodging sweet," there was also involved some antique belief in dispelling bad influences which may be classed as primitive sanitation.

The use of smoke in worship, however, seems to have arisen from the observation that this ghostly element of combustion dissolved in the air, thus supplying a messenger to the unseen. It must not be forgotten also that to unspoiled senses the odor of smoke would be strikingly pungent and perhaps the most remarkable attribute of fire, a potent and far-reaching means of calling the attention of supernatural beings, propitiating or frightening them. The Homeric and Jewish idea was that a sweet savor was pleasing to divinity, and this appears to be the most widely diffused idea connected with the burning of incense in worship, while offerings to the fire which at one time were customary may have been for the double purpose of pleasing the spirits with incense and of feeding them. The offering was consumed by the fire and dissappeared from human sight, thus being analogous to the practice of throwing offerings into springs or rivers.

J. N. B. Hewitt informs the writer that the Iroquois used tobacco smoke to make authentic a petition, and states that in the New Year ceremony the life god, whose vitality is supposed to wane during the year, presents a petition for restoration, and in order to give value to his petition a portion of the rite is marked by the burning of tobacco for this purpose. The solemn ceremonies also connected with the calumet may involve this idea. The calumet is passed around in order of official seniority during the council, and he who holds it affirms his speech by blowing a cloud of smoke. Similarly, in the ratification of peace the pipe was an important adjunct, without which the terms would not be binding. It is probable here, as in many other rites connected with the use of incense, that the smoke is designed to open communication with the spirit world by attracting the attention of the intangible beings. Mr. Hewitt says, however, that it is the tobacco rather than the odor that is offered as a sacrifice to the deities; that is, the soul, or the reality, of the tobacco is what reaches the gods. By means of separate acts there is a twofold use of tobacco in a peace or other council, the one to compose the minds of the councilors and the other to invoke the good will of the gods to whom it is offered in sacrifices.

Incense was probably at first the smoke of wood or of leaves, then later selected, compounded of several materials, and made sacred by rites. It was finally sought all over the world, and a commerce in "frankincense and myrrh" was one of the chief agencies in bringing a knowledge of the people of the Tropics to those of northern zones.

The incense from South America, according to Humboldt, was from the *Icica gujanensis* and *Icica tacamahaca.* That used most commonly in Mexico and Central America was the gum of the *Protium heptaphyllum,* called copal by the Spanish. This tree is also near *Bursera,* from which genus the most precious incense gums of the world are derived. "The Mexicans and all the inhabitants of New Spain made use (which they pursue yet somewhat to-day) in their offerings of that incense of copal, a kind of white gum which they call *copalli,* for incensing their gods. They had not recourse to our true incense, because it was not found in their country. It was copal that the satraps used in the temple and everyone in the private houses, as we have said above." Tozzer states that the sap of the rubber tree was used by the Lacandones. The wood and leaves and

and the resins of the pine trees in Mexico had important cult uses. Pine needles are used as incense by the Hopi, as they are by the Tibetans.

In the descriptions of the home life of the Mexicans transmitted by the early chroniclers it is stated that vases filled with smouldering incense diffused their perfumes through the rooms, and numerous mentions of such usage give the impression that it was customary to burn odorous substances as a matter of refinement and for personal pleasure, just as the use of tobacco became secularized.

NEW FIRE

One of the most interesting survivals of the crude philosophy which apparently developed anciently concerning fire is the new fire. This philosophy was based on the observed birth, growth, and decay of animate and inanimate things. It may be called the pre-evolutionary theory. The Mexicans transferred this idea to the life of the gods, who must be assiduously nourished, and to the sun as chief of the gods. Out of this idea grew all origin ideas, the golden age and the fall of man. It was conceived that fire grew old and ineffective for the preservation of the well-being of the family, and, by extension to the social group or tribe. The family fire was always regarded with superstitious reverence which had survived from times of the highest antiquity, a fragment of the attitude of man toward the primitive fire as an awe-inspiring phenomenon. Based on the philosophy of the spiritual decay of fire, a widespread custom sprang up which required the renewal at stated intervals, usually one year, but sometimes longer, as among the Mexicans.

The kindling of new fire is, or recently was, almost universally practiced by the tribes of men. So widely spread is the conception of new fire that one may surmise its inheritance from a common center before one of the great migrations. The idea is antagonistic to to that of perpetual fire, in fact it causes the total loss of fire, a contingency jealously guarded against before the invention of methods of making fire artificially. In this light we may assert that the new fire was posterior to the invention mentioned.

Some notes, admittedly few of the great number, show the new fire practice in the major divisions of the world.

"Formerly when an epidemic prevailed among the Iroquois despite the efforts to stay it, it was customary for the principal shaman to order the fires in every cabin to be extinguished and the ashes and cinders to be carefully removed; for it was believed that the pestilence was sent as a punishment for neglecting to rekindle 'new fire,' or because of the manner in which the fire then in use had been kindled. So, after all the fires were out, two suitable logs of slippery elm (*Ulmus fulva*) were provided for the new fire. One of the logs was from 6 to 8 inches in diameter and from 8 to 10 feet long; the other was from 10 to 12 inches in diameter and about 10 feet long. About midway across the larger log a cuneiform notch or cut about 6 inches deep was made, and in the wedge-shaped notch punk was placed. The other log was drawn rapidly to and fro in the cut by four strong men chosen for the purpose until the punk was ignited by the friction thus produced.

"Before and during the progress of the work of igniting the fire the shaman votively sprinkled *tcar-hu-en-we*, 'real tobacco,' three several times into the cuneiform notch and offered earnest prayers to the fire god, beseeching him 'to aid, to bless, and to redeem the people from their calamities.'

"The ignited punk was used to light a large bonfire, and then the head of every family was required to take home 'new fire' to rekindle a fire in his or her fireplace."[92]

"At the sacrifice of the white dog, which was the New Year's festival and great jubilee of the Iroquois, the proceedings extended over six days. * * * The fire was kindled by swiftly revolving, by means of a bow and cord, an upright shaft of wood with a perforated stone attached to it as a fly wheel. The lower point rested on a block of dry wood, surrounded by tinder, which was speedily ignited. This is the ordinary process still in use among many of the Indian tribes."[93]

The Cherokee (Iroquoian) at the annual corn dance obtained new fire from one freshly kindled in the town house.[94]

Once a year, about July, the Creeks put out all the fires throughout the nation; they fast the next two days, then the fire is lighted again according to their old fashion by drilling with a hard piece of wood on a soft one till it catches, which soon happens; thus all the fires are again lighted and universal feasting ensues.[95]

In the Minitaree Green Corn Dance, a ceremony of rejoicing in the maturing of crops practiced by many North American tribes, corn is boiled on the fire, which is then put out by removing it with the ashes and burying them. New fire is made by desperate and painful exertion by three men seated on the ground facing each other and violently drilling the end of a stick into a hard block of wood by rolling it between the hands, each one catching the stick in turn from the other without allowing the motion to stop, until smoke and at last a spark of fire is seen and caught in a piece of punk when there is great rejoicing in the crowd.[96]

---

[92] J. N. B. Hewitt. Amer. Anthrop., vol. 2, January, 1889, p. 319.

[93] Sir Daniel Wilson. Pre-Historic Man, vol. 1, London, 1865, p. 128.

[94] James Mooney. Amer. Anthrop., vol. 2, 1889, p. 167.

[95] Benard Romans. A Concise Natural History of East and West Florida, etc., vol. 1, 1775, p. 98.

[96] George Catlin. Rept. U. S. Nat. Mus., 1885, p. 315.

Frank Cushing once told the writer that the new fire which is lighted in Zuni once a year, with the widespread custom of extinguishing all other fires previously, must be kindled by a man who has been struck by lightning. This man is a priest of the bow.

The Hopi Indians of Arizona observe an elaborate rite called New Fire Ceremony, more complicated in its primitive dramatization than any of the new fire rites known. The ceremony revolves around the making of new fire, but lacks the distribution to the domestic hearths. The fire instead is cast away in a special rite which is part of the ceremony, and is apparently regarded too sacred for ordinary uses. Even the ashes are carefully removed.[97]

In Mexico the new fire was a great national ceremony. On the eve of the fire kindling the people sat in their houses full of fear that the priests should not be able to grind out the spark, and that the gods should render them fireless. The rite was performed at the Hill of the Star and from thence the new fire was carried to the hearths over the country. Sahagun says:

"When the fire was made the inhabitants renewed their installation, they gave great feasts and rejoicings, threw on the fire much incense and incensed their gods toward the four cardinal points with their censers of terra cotta in the midst of the courts of their habitations."[98]

The Nahuas made a new fire for a different purpose: "Signal to open battle was given by the chief priests by making new fire and by blowing in their porto-voix."[99]

The new fire and sacred fire was kindled in ancient Peru. "Each year at the autumnal equinox a 'new fire' was kindled by collecting the sun's rays on a burnished mirror, and this fire was kept alive through the year by consecrated maidens (*acllacuna*) analogous to the Roman vestal nuns. These vestals lived in convents presided over by matrons (*mama cuna*). If the fire happened to go out it was an evil omen. If a nun broke her vow of chastity she was buried alive,[1] just as in Rome. They were treated with much deference; each temple of the sun had a convent connected with it; the vassals were the sun's wives; the Inca was representative of the sun Viracocha."[2]

In Europe we find many references to new fire customs, ancient and modern. There were no ceremonies comparable in detail with those of America, but there were more folk customs so far as is known connected with the use of the new fire. In particular are noted the employment of the new fire for the benefit of crops, animals, and for prevention of disease. These instances are most interestingly incorporated in Mr. Frazer's Golden Bough, to which scholars must refer. Need fire, as new fire is termed in European countries, appears to be derived from Anglo-Saxon "*gnidan*," to rub, evidently referring to the requirement of securing pure fire from wood friction. Apparently the sacred fire of the Druids was a perpetual fire from which, when all house fires were extinguished, they were rekindled on a certain day.

---

[97] J. Walter Fewkes. The Tusayan New Fire Ceremony. Proc. Boston Soc. Nat. Hist., vol. 26, 1895, pp. 422-458.

[98] Sahagun.

[99] Idem, p. 528.

[1] Garcilasso, Book 4, cap. 3.

[2] John Fiske. The Discovery of America, vol. 2, 1892, pp. 343-344.

In Japan the fire festival of Kyoto has some of the elements of the new fire, but particularly is concerned with the perpetuation of a sacred fire which is thought to have been kept burning for 2,500 years. All ceremonials touched with the genius of the Japanese are much elaborated, and become difficult of comparison with those of other countries.

Among the Taiyals of Formosa new fire is made by the chief, who shuts himself in a house to perform the ceremony. This takes place on New Year, which comes at the beginning of harvest.[3]

In Africa, while there are fewer observations, the new fire custom is prevalent. The M'Bamba Tribe of Angola in time of pestilence at the first rains put out their fires in the village and the chief goes out into the bush to start new fires by rubbing two sticks. In catching the fire he uses tinder. The people clear out all ashes and take them to the cross trails and scatter them, together with one grain of all the plants that they grow. Then they go out into the bush where the fire is being made, and the medicine man gets green shoots from the ends of branches and puts them in an earthen vessel with water, and all the people come and wash themselves in it. He then selects a certain tree, peels off the bark, pounds it in a mortar, and all the people smear themselves with it in purification. Everyone then takes part of the fire made there and goes home.[4]

In central Africa it is a custom after the birth of a child that the fire is put out in the house and rekindled.[5]

On a death the Thonga of South Africa, "without delay the fire which was burning in the funeral hut is removed and carried onto the square. It must be carefully kept alight. This is a taboo. Should there be rain it must be protected. All the inhabitants must use this fire during the next five days. It will be put out by the doctor with sand or water on the day of the dispersion of the mourners. He will then light a new one and everyone will take from its embers to kindle his own fire in the different huts. It is one of the conditions of the purification of the village."[6]

---

[3] Information by S. Ishii. March, 1919.

[4] Information by Rev. Heli Chatelain.

[5] Stohlman. Mit Emin Pascha in Hertz von Afrika.

[6] Henry A. Junod. The Life of a South African Tribe, vol. 1, 1913, p. 135.

PERPETUAL FIRE

There was thought to be much virtue in the perpetuation of fire. Many cults, ancient and modern, kept up fire altars with jealous care lest the precious guardian of the well-being of the people should go out and cause various dreaded calamities. In this custom has been seen the idea of the association of the continuity of life with the continuity of fire. In ancient philosophy this effort at rationalization often appears. It is a normal generalization to associate warmth with life. On the other hand, it is allowable to see in the perpetuation of fire a survival from the period before the art of making fire artificially was known, when the preservation of fire was essential. This is the opinion of Mr. Frazer and other students. So often is the custom of perpetual fire met with in studies of all ages and tribes that whatever its origin or idealization it must be regarded as a central phenomenon in man's association with fire. While the cult of perpetual fire is dedicated to a certain being or to many of the spiritual world, the family fire partakes of some of its characteristics. In folk customs the long-maintained fire has been perpetuated up to the present.

"In the middle of the hut of the first chief [Thonga, South Africa] a perpetual fire burns, and it must never be allowed to go out. It must be fed with special wood provided by a certain clan. It is taboo to take embers from this fire. Should it go out it must be ceremonially made by rubbing two sticks by the magician. The hut and chief's wife, keeper of the sacred fire, are taboo." [7]

The Osage Indian sacred fire is in the house of the chief and is placed midway between the two doors. Fire taken therefrom by the people to start their house fires was thought of as holy and as having power to give life and health to those who used it. It was called the gentle or peaceful fireplace, in contrast with seven fireplaces of each of the three divisions which were dedicated to war and associated with violence and death.[8] This fire is not in the class of perpetual fires, but the term sacred fire is figurative.

The Pueblo Indians of New Mexico and Arizona do not maintain the perpetual fire, and there is no reliable evidence that they ever did. Writers have attributed the custom to them on account of supposed similarities of the Pueblos with the Mexicans, and at an era when the romantic aura of Montezuma clothed everything Pueblo. By a mistranslation of the Spanish word estufa applied to the meeting place of the clan fraternities it became among other things, which it is not, a bathhouse. The fireplace of the estufa or Hopi kiva is as often cold as not, fire being laid on it when ceremonies are in progress or on special occasions. The Pueblos had a well-developed fire cult, now much decayed and obsolete, but their practices were magical, and perpetual fire was absent. The discovery of a prehistoric "fire temple" at Mesa Verde in connection with cliff dwellings by Dr. Walter Fewkes shows the fire cult at its zenith, but does not render it possible to say that perpetual fire was an element of this cult. If the perpetual fire was ever a Pueblo institution, these tribes have now advanced to the belief that fire rubbed ceremonially from the two sticks is adequate for the purposes of worship.

---

[7] Extracted from The Life of a South African Tribe, vol. 1, 1913, p. 364.

[8] Alice C. Fletcher and Francis La Flesche. The Osage Tribe, 36th Ann. Rept., Bur. Amer. Ethnol., 1921, p. 69.

The sentiment of the perpetuation of the family fire which serves to connect the past with the present is uncovered in the custom of many persons who still carry an ember from the old house to the new when changing the dwelling place.[9]

STRANGE FIRE AND PURE FIRE

The idea that fire could be contaminated and that there were various grades and classes of fire is of early development. It is represented in the innumerable taboos guiding the manners in respect to attitude toward fire.

Thus it is forbidden for a man to spit into a fire; he would wither and dry up soon.[10]

It is forbidden to point a sharp instrument toward the fire and to burn certain unworthy substances in the fire.

Wild fire and strange fire are terms applied to fire that does not comply with certain regulations which purity prescribes. Fire which has been stolen from a family hearth is of this class, as it becomes in alien hands the means of practicing witchcraft harmful to the family.

In contrast with strange fire we have pure fire. The length to which the process of obtaining pure fire was carried is observed by the customs of the Persian fire worshippers, who held that the purest fire was that of lightning, which came from the clouds. The strongest fire, which kills all demons, is compounded of 15 different fires. The fire sticks were venerated, and Atharavan or fire priest made the sacrifices. This fire was not to be contaminated by the breath of the priest, who was compelled to wear a white cloth over his face when sacrificing.

The Hindu customs were similar and represent an extremely burdensome process in obtaining pure fire.

The enigmatic statement in the Bible as to the offering of strange fire has never received explanation. "1. And Nadab and Abihu, the sons of Aaron, took either of them his censer, and put fire therein, and put incense thereon, and offered strange fire before the Lord, which he commanded them not. 2. And there went out fire from the Lord, and devoured them, and they died before the Lord."[11]

---

[9] Information by Miss Anita Long, January, 1911.

[10] George Brown. Melanesians and Polynesians, 1910, p. 206.

It is possible that here is an example of the infraction of the regulations as to pure fire, although so far as the text goes the offering was made in the customary manner.

A reversion to first principles and a clear statement of former pure beliefs was a feature of the Ghost Dance religion promulgated among the American Indians several decades ago. It was proscribed that:

"They must have done with the white man's flint and steel and cook their food over a fire made by rubbing together two sticks, and this fire must always be kept burning in their lodges, as it was a symbol of eternal life, and their care for it was an evidence of their heed to the divine command."[12]

This command was observed by most of the tribes and had much to do with the perpetuation of the knowledge of the method of fire making by means of two sticks.

BONFIRES, ETC.

There is a large class of fire observances of almost universal provenance. Reference is here made to bonfires kindled for various motives, the basis of which is superstition handed down from the past. Frazer in The Golden Bough cites numerous instances, and their application to their supposed benefit to agriculture and in general to the social organization. Uncivilized tribes holding ceremonies at night make a chief feature of the bonfire, around which they dance. A good example of this is the Navaho night chant with its weird and picturesque fire dance.[13]

Among civilized peoples some such observances have degenerated into an expression of joy or a form of exaltation, and such bonfires are called by the French feu de joie.

In the Ghost Dance of the northern Cheyennes, "four fires were built outside of the dance circle and about 20 yards back from it, toward each of the cardinal points. These fires were built of long poles set up on end, so as to form a rude cone, much as the poles of a tipi are erected. The fires were lighted at the bottom, and thus made high bonfires, which were kept up as long as the dance continued."[14]

LIGHTNING—SUPERSTITIONS AND CUSTOMS

The attitude of man toward the amazing phenomenon of lightning has its origin in fear and a desire for protection from its effects. The two ideas of propitiation and veneration also enter into the attitude. A theory of the origin which is a causational myth attributing lightning to some intangible beings and the stroke to some material object as a celt, is worked out. Fetishes and formulas for individual and general protection and rituals for removing the bad consequences in a superstitious sense originate in great number and variety. As to the beliefs and customs of early man with respect to lightning there can be only conjecture, and suggestions on these points may be advanced by observations on the uncivilized races. It is believed that lightning was more common in the glacial period than now. If this be so it is evident that there is a great heritage of fear of lightning in the race.

---

[11] Leviticus x, 1, 2.

[12] James Mooney. 14th (pt. 2) Ann. Rept., Bur. Amer. Ethnol., 1896, p. 675.

[13] Washington Matthews. The Mountain Chant, 5th Ann. Rept., Bur. Amer. Ethnol., 1887, pp. 379–465.

[14] G. B. Grinnell, Journ. Amer. Folk-Lore., vol. 5. Mooney. 19th (pt. 2) Ann. Rept., Bur. Amer. Ethnol., 1900, p. 925.

The customs in regard to the actual stroke of lightning are very interesting and point to several lines of study in the research on fire.

Lightning taboo is observed among the Apache Indians, who will not eat an animal that has been struck by lightning.[15]

Capt. John G. Bourke says that the Apache made talismans of lightning-struck pine, cedar, or fir from the mountain tops. Also, a phylactery examined by him had a small cross of lightning-riven pine. It was called "intchi-dijin," the black wind.[16] Captain Bourke "was led to believe that the rhombus of the Apache was made by the medicine men from wood, generally pine or fir, which had been struck by lightning on the mountain tops. Such wood is held in the highest estimation among them, and is used for the manufacture of amulets of especial efficacy."[17]

For the [Zuni] scalp ceremonial they (the images) must be made from ashekia (*Pinus ponderosa*) that has been struck by lightning."[18]

The Omaha say when lightning hits a tree, "the thunderbird has lit on the tree." The symbolism of lightning lines drawn down the arm was known to the Omaha. The initiation of a boy into the tribe was by a ceremony. A ball of grass was hurled to the ground at the close of the ceremony and made to burst into flames, symbolic of lightning. These Indians conceived lightning as feeding on green wood and leaving a worm at the root.[19]

The Cherokees think mysterious properties attach to the wood of a tree which has been struck by lightning, especially when the tree itself still lives, and such wood enters largely into the secret compounds of the conjurers. An ordinary person of the laity will not touch it for fear of having cracks come upon his hands and feet, nor is it burned for fuel for fear that lye made from the ashes will cause consumption. In preparing ball players for the contest the medicine man sometimes burns splinters of it to coal, which he gives to the players to paint themselves with in order that they may be able to strike their opponents with all the force of a thunderbolt. Bark or wood from a tree struck by lightning, but still green, is beaten up and put into the water in which seeds are soaked before planting, to insure a good crop; but, on the other hand, any lightning-struck wood thrown into the field will cause the crop to wither, and it is believed to have a bad effect even to go into the field immediately after having been near such a tree.[20]

---

[15] E. Palmer. Amer. Nat., vol. 12, 1878, p. 312.

[16] 9th Ann. Rept., Bur. Amer. Ethnol., 1892, pp. 587, 591.

[17] J. G. Bourke. Medicine-men of the Apache, 9th Ann. Rept., Bur. Amer. Ethnol., 1892, p. 478.

[18] Mrs. M. C. Stevenson. The Zuni Indians, 23rd Ann. Rept., Bur. Amer. Ethnol., 1904, p. 113.

[19] Alice C. Fletcher and Francis La Flesche. The Omaha Tribe, 27th Ann. Rept., Bur. Amer. Ethnol., 1911, pp. 457, 127, 188.

Prof. O. F. Cook, of the Department of Agriculture, who returned from a journey in Liberia, gave the writer a most interesting account of a custom of the Golas of that country. The Golas apparently do not use fire sticks, but preserve fire carefully. When fire follows a stroke of lightning they hasten to secure a light from it, and putting out all the fires in the village, kindle them again from the new fire. Lightning is very common in the Gola country, where in certain seasons there are five or six thunderstorms in one day. I regard this one of the most important contributions to the question of the origin of fire, and it shows the unexpected attitude toward the fire from lightning.

Customs concerning lightning among the Bahuana Tribe of the Congo are given by Torday.

"*Burial.*—A dead man is buried with his face to the west in a sitting position, and with him his clothes and weapons, with some food and palm wine; if he was a maker of palm wine his implements are buried with him. Women are buried in the same manner, but their pots are buried with them, whereas in the case of a man they are broken on the grave. A man killed by lightning is buried full length on his back. Men in mourning paint the forehead black, women the whole face.

"*Explanation.*—There are two noncorporeal parts of a man, the '*bun*' and the '*doshi*'; all creatures have the latter; it leaves the body in dreams, and after death hangs about in the air, visits its friends, haunts its enemies, and so on; animal and fetishes have '*doshi*' but no '*bun*.'

"The '*bun*' disappears at death, but it is said to enter the body of a large animal if its owner has had any fetishes; a man without fetishes can cause his '*bun*' to appear to his friends in the form of a vaporous body. If a man is killed by lightning his '*bun*' is destroyed, but suicide does not affect the continued existence of the '*bun*' and the '*doshi*'.

---

[20] James Mooney. Myths of the Cherokee, 19th (pt. 1) Ann. Rept., Bur. American Ethnol., 1900, p. 422.

"I did not hear any Bahuana stories, but some of their mythical ideas are curious. They say that lightning is a cat which lives in the clouds and comes to earth when it is hungry to eat a tree or man. By the side of this their explanation of the rainbow as a big snake is commonplace; they say it feeds on fish and shows itself sometimes when it has had enough to eat."[21]

The Parsee regarded as the purest fire that of lightning, which came from the clouds. The sacred fire was kindled from fire by lightning whenever opportunity offered.

The Circassians venerated the tree struck by lightning. Beneath such a tree the criminal found refuge.[22]

Pom K. Soh, a highly educated Korean, informed the writer that in Korea lightning-struck wood was used for sword hilts and as charms against evil spirits. He said that the popular belief is that spirits take refuge under trees and are killed by lightning. People are advised to take off their large hats during a storm for the same reason. Another belief is that bad air which brings on disease is purified by lightning.

The Japanese, according to Lafcadio Hearn, regarded thunder as an animal which rends trees with its claws. The wood of a lightning-struck tree is a cure for toothache.[23]

Belief in the tangible evidences of the lightning stroke is offered by the almost universal superstition concerning thunderbolts. The gewitler stein, lightning stone or wedge that splits the trees, of German Canadian folk-lore, may be taken as the type of implement. The conception is of a wedge, a tool capable of riving, hence stone celts of ancient workmanship are given the name thunderbolt, as piedras del rayo, applied to the celts found in portions of the West Indies. Among the Thonga of South Africa:

"Lightning is called 'lihati' (li-tin), and is said to be caused by a bird called 'ndlati' (yi-tin). These two words, etymologically speaking, seem to be related to each other. They possess the feminine suffix ti, which is met with under the forms eti, ati, oti. This bird is also called 'nkuku wa tilo' amongst the Ra-Ronga, the cock of heaven, or 'psele dja tilo,' the hen of heaven, and magicians know how to determine its sex when the bird has fallen.

"The thunder is attributed either to the bird itself, or more frequently to heaven. The proper expression for 'it thunders' is 'tilo dji djuma,' 'heaven roars.'

"In the northern clans those who practice magical arts add many other particulars to the story, some of which may have been borrowed from the Pedi magicians, who seem to possess a more complete explanation of the phenomenon. According to them the 'ndlati' (Pedi, dali) is a bird of four colors, green, red, black, and white, which lives in the mountains, preferably at the confluence of rivers. The medicine men of former times knew its hiding place, and had even found the eggs of the bird in a nest floating on the water. When a thunderstorm breaks the bird flies to heaven into the clouds; there may be scores of them, but one only will be dangerous (lebya) and cause death. It rushes down to the ground, strikes a tree on its way, tearing its bark and its wood and throwing it down; or it falls on a hut and burns it, or on a man and kills him. Having reached the soil the bird can be caught, and I heard people seriously asserting that four of these, unable to fly, had been found the previous year in Sikororo's country. Or the bird enters the ground to a depth of 2 to 3 feet and remains there in its own form, or (this is the most common saying) deposits its urine ('murundju'), which has already caused the flash of lightning, and flies away back to the mountains. The magician who understands 'the treatment of heaven' comes and digs at the spot; there he finds a kind of gelatinous substance which solidifies after a little time. I possess a little of this curious drug, given to me by a Pedi magician, by name Mudjumi; it resembles a piece of chalk and is considered very valuable on account of its rareness, and because it helps in the manufacture of the wonderful medicine of heaven. Should a village have been struck with lightning the magician of heaven will come and dig out this foreign body; if he finds it the taboo is removed. If he does not the whole village must move to another place. In the same way, it is taboo to warm oneself at a fire made of the wood of a tree that has been struck by lightning or to use it as fuel.

---

[21] E Torday. Camp and Tramp in African Wilds, p. 174. New York, 1882–1895; Philadelphia, 1913.

[22] E. Reclus. Universal Geography. Ed. Keane.

[23] Unfamiliar Japan, New York, 1894, p. 501.

"Happily this dreadful bird can be prevented from killing and burning by magicial means. Both the Pedi Mudjumi and the Thonga Makasane possessed the enchanted flute by which they could force heaven, or the bird of heaven, to spare them. Mudjumi having sold me his flute, I can describe it at leisure. It is made of a hollow bone 5 inches long, covered with Varan skin, filled at its larger extremity with a black substance like wax. Inside, to keep it clean, there is a vulture's feather. The bone is said to have been taken from the 'ndlati' bird; the wax substance has been made from powder obtained by drying up and pulverizing a little of the heart, the eye, the bones, the feathers, and the flesh of the bird. In the wax are imbedded three seeds of *Abrus precatorius*, the 'lucky beans' well known in South Africa, a round seed of a splendid coral color with a black spot, very much used in Thonga magic. This addition of *Abrus precatorius* intensifies the sound of the flute and enables it to reach heaven. The magician, seeing the thunderstorm approaching, climbs up the hill without any fear, blows in his flute: psee . . . psee . . . psee . . . and shouts 'You! Heaven! Go further! I have nothing against you! I do not fight against you!' He may add in a threatening tone: 'If you are sent by my enemies against me, I will cut you open with this knife of mine.' The thunderstorm will then pass away."[24]

The myth of the thunderbird best developed or best described from the northwest coast of America can be traced among tribes from several other localities. The conception is of a huge bird riding the storm and hurling bolts, which are fishes concealed in its plumage. It would be easy to see in the thunderbird a personification of the storm cloud. If the man eagle of the sky, a Hopi myth, belongs to the thunderbird cycle, the bolt motive is omitted on account of other explanations for lighting. Lightning is a province of the Manitous of the northern plains and northeastern tribes. Some resemblances appear here to the thunderbird.

Somewhat advanced beliefs as to the origin of lightning appear in the mythology of the tribes of the southwestern United States and Mexico. Herrera, writing of Mexico at the period of the conquest, says:

"And believed that thunder and lightning were living creatures that came down from heaven, and when a flash of lightning killed anybody they said the gods were angry."[25]

An interpretation of the Mexican belief cited is probably to be seen in the belief of the Zuni Indians of New Mexico. The Zuni myth of the twin gods of war, children of the sun, represents the pair stealing the lightning, a perquisite of their father, and having sport with it. The lightning is represented as a ball rolled along the clouds.[26]

In the dramatizations of natural phenomena the Hopi at the beginning of the Snake Ceremony whirl the rhombus or bull roarer, simulating apparently the storm. The vane is usually painted with a zigzag line, which is the symbol of lightning among all the Pueblos. The Zuni and Hopi represent lightning in their ceremonies with an extensible rackwork headed with an arrow shape. The sudden darting out of this device is very startling. Among the Pueblos lightning is regarded as having both a good-working and bad-working effect. The Hopi are pleased when lightning strikes in their fields, as they believe that it fertilizes their crops and makes the yield abundant. The contrary is true when lightning strikes the pueblo, as will be shown later. The Pueblo have the most extensive symbolism of lightning. The symbol appears on religious paraphernalia, is painted on pottery, and woven in textiles. Lightning is assigned to the four or more cardinal points according to Pueblo geocentricism. It is associated with clouds and rain. The Zuni have a cause and effect symbol representing the rain clouds of the four quarters as high terraced black cumuli arranged as the swastika. In the angles strike lightning, depicted as arrowheads, and at the center is the body of water stored up from the resulting rains. From the borders of this figure spring sprays of vegetation.

---

[24] H. A. Junod. The Life of a South African Tribe, vol. 2, pp. 290–292, Neuchatel, 1913.

[25] Herrera. General History of America, vol. 3, p. 112, London, 1726.

[26] F. H. Cushing. Zuni Folk Tales, New York, 1901.

As to the maleficent effects of lightning there are many beliefs calling for special observances. Among the Hopi when a house is struck by lightning it is necessary to hold a ceremony; it is conjectured that its intent is to remove the bad influences or to set the pueblo right as to the protective beings. This ceremony was under the control of the yaya or fire priests, whose order is now extinct. Unfortunately, no scientific observer has seen the ceremony and there is no record of the observance. The last ceremony was held over a blasted dwelling about 20 years ago.

Among the South African Thonga:

"If lighting strikes the '*hubo*' it is a very bad omen. The medicine man, who has the power of 'treating the place struck by lightning,' is called in. Should he be able to exhume from the ground the mysterious bird which causes lightning, or at least the coagulated urine which it has deposited, and which is called heaven (see Part V), the people are allowed to stay. But if he does not discover it deep down in the soil the village must move, as the presence of the mysterious power of heaven inside the circle of huts would bring disaster. This is a taboo."[27]

A widely spread folk belief in Europe and America is that sweet milk is efficacious in putting out a fire started by lightning. The writer has seen this custom in practice. This bit of folklore has probably a very ancient origin, which Mr. Frazer could delightfully investigate.

As to charms, fetishes, and observances to insure protection from lightning, from Junod's work above cited is quoted:

"The sala and the kwakwa are two species of the genus *Strychnos* (perhaps one of them is the *Strychnos spinosa*) which furnish chemists and poisoners with the well-known drug strychnine. Does the fruit contain any proportion of this substance? I do not know. It has never been known to kill anyone, although it may be the cause of many intestinal troubles which naturally result when the natives, having no more maize or sweet potatoes, live on nothing but this particular fruit. Strange to say, the kwakwa stones are credited with the power of attracting lightning; the old women say that when making 'nfuma' these large white stones must never be allowed to lie in a heap in the open air; lightning would surely strike the village were any such imprudence committed. It is a taboo."[28]

---

[27] H. A. Junod. The Life of a South African Tribe, London, 1912, p. 289.

The Botocudos Indians of the Rio Doce, Brazil, have a curious custom. "During a thunderstorm they shake a burning brand and shoot arrows toward the sky to appease, by imitation, the powers of the storm."[29] Might the classic story of Ajax defying the lightning have such an interpretation?

More reliance is placed on charms in most parts of the World. In Japan salt is a charm against lightning. Visible tokens or fetishes are most common, and some of these incorporate several protective ideas. Thunderstones are widely believed to be a protection. Some years ago Dr. Edwin Kirk secured rubbings of supposed coins or medals found by a miner in the interior of Alaska. The rubbings were sent to the distinguished oriental scholar, Dr. Berthold Laufer, of the Field Museum of Natural History, Chicago, Illinois. An extract from his letter follows:

"In regard to the two Chinese objects found in Alaska, they represent amulets in the form of coins, which are worn for personal protection. One, which I numbered A on your rubbing, shows on the obverse the 12 animals of the zodiac, accompanied by their names in Chinese, which are identical with the designations of the duodenary cycle. The reverse shows the eight pa-kua or trigrams anciently used in divination, each provided with its Chinese name. The same design occurs on the reverse of the other charm, which I designated B. This charm, as shown by the inscription on the obverse, was intended as a protection for the owner from lightning strokes. These charms emanate from the notions of Taoist religion and are supposed to have been written by Lao Kün, the founder of Taoism, who addresses the god of lightning that he should only hit the demons and spare the wearer of the charm. An original of this charm is in the collection of this museum. A great number of such charms are illustrated and described in the new book of H. Doré, Superstitions of China, published in French and English by the Jesuits of Sikhawei. If you should desire more information on this subject, please let me know and I shall be glad to respond. Both charms were cast under the Manchu dynasty, but it is impossible to assign to them a fixed date."

The Hopi Indians tie two stone arrowheads to a little amulet of fiber and use it as a charm against lightning.[30] The arrowhead probably stands for the celt or thunderbolt.

---

[28] The Life of a South African Tribe, vol. 2, p. 17.

[29] D. G. Brinton. The American Race, New York, 1891, p. 238.

[30] Walter Hough. The Hopi Indian Collections in the U. S. National Museum, Proc. U. S. Nat. Mus., vol. 54, p. 288.

RAIN MAKING

Fire enters extensively in the many customs connected with rain making. The chief idea here is the association of lightning with rain and the similarity of fire and lightning, thus pointing to fire as a valuable agent in producing rain.

From Junod's thorough work on the Thonga of South Africa, the following extract gives an idea of the working of the primitive mind that by simulating clouds with smoke and lightning by fire, rain may be made to fall.

"Having come back with the precious charm, when summoned by any chief to act as rain maker Mankhela employed it in the following way.

"He first asked the chief to kill a black goat or sheep (a he-goat or a ram if the bones said so); the head, at any rate had to be black. The heart was pierced with a puncheon and the blood flowed. He carefully washed the horns with the blood and smeared them later on (horola) with the 'psanyi' found in the intestines of the animal. Then he took his ntsiko, viz, the two pieces of wood which acted as his flint and steel, poured a little of the powder into the notch of the female stick and made fire by the rapid friction described on page 33. In the meantime Mankhelu was praying as follows: 'Here are the drugs Rivimbi of Tsome (Rivimbi's father): Give us rain.' Then he invoked his own gods, saying 'Go to Rivimbi for me and come along here all of you to make the rain fall.' This performance is a 'mhamba,' a means of calling the gods, especially Rivimbi, 'the master of this mhamba.' After a while the wood began to burn; leaves of the 'nembe-nembe' bush (*Cassia petersiana*) were placed on it and a black smoke rose and ascended to heaven. Then the clouds appeared and soon the thunderstorm broke. A feather of the ndlati bird of lightning was put among the leaves as a protection against thunderbolts."[31]

From the same source are native beliefs as to why rain is prevented from falling.[32]

The Santa Barbara Indians at San Buenaventura, California, possessed a rain-making charm stone which they placed centrally on a primitive altar, and one of the things they especially prayed for was rain to put out the fires in the mountains. This stone, which is now in the United States National Museum, was thought to be efficacious in bringing rain and other desirable things. It is a waterworn pebble of green jasper.

The Apache Indians of the White Mountains of Arizona annually burnt off large tracts of forested land under the delusion that the conflagration would bring rain. The idea here appears to be magic by imitation. Quite as foolish rain-making schemes and ideas on the cause of rainfall have been foisted on modern times.

---

[31] H. A. Junod. The Life of a South African Tribe, vol. 2, p. 299, Neuchatel, 1913.

[32] Idem, p. 293.

Among agricultural peoples the use of fire magic to produce rain is universal. A multitude of examples are cited by Frazer.[33]

MARRIAGE FIRE

As with nearly every other event of life in earlier times, fire played a more or less important part among the ceremonies, and in marriage rites there is no exception. Torches and other illuminations are familiar in classical Roman writings. The custom was to conduct the bride in the night to the home of the bridegroom by the light of torches. Horace says: "One out of the many worthy of the nuptial torch was nobly false to her perjured parent and illustrious to all posterity." [34]

Pere Lafitau with his customary thoroughness discusses nuptial torches and consecrated wood, comparing classical and American Indian observances.[35]

The Altaians have a pipe-smoking ceremony on the acceptance of the offer of marriage. The ceremony of blessing the bride requires her to bow to the fire during the ceremony, to her house fire, to the fire in the bridegroom's house, and to offer a piece of meat and butter.[36]

The bridegroom on entering the new abode must kindle a new fire with his flint and steel, for no coals can be brought into the yurta from any other fire for the purpose. From the manner in which the sparks fly the future life of the young couple is augured.[37]

Among the Buryat Mongols, near the close of the ceremony "the bridegroom enters the yurta to put some grease on the fire; and when the bride and her party follow him in, grains of corn are thrown upon their heads." [38]

Among the Koryaks, "when the bride approaches the house of her bridegroom's parents, the latter come out with firebrands taken from the hearth to greet her.[39]

In reference to the marriage customs of the Yakuts:

"Priklonski says that the bride approaches the fire from the north, and throwing into it three sticks brought from her own yurta, and a piece of butter, pronounces these words: 'I come as mistress to rule the hearth.' Then she bows to her father-in-law and mother-in-law and the feast begins, the young couple being seated apart from the rest of the company. After the feast the married pair retire to the sleeping place prepared for them."[40]

---

[33] The Golden Bough. London, 1890.

[34] Horace. Ode XI, Book III.

[35] Lafitau. Moeurs, vol. 1, Paris, 1724, p. 578.

[36] M. A. Czaplicka. Aboriginal Siberia, 1914, p. 77.

[37] Idem, p. 116.

[38] Idem, p. 119.

[39] Idem, Quot. from Jochelson, The Koryak, p. 84.

Among the Ainu on the betrothal of an adult man:

"The bridegroom's father takes a small sword, and placing it in the hands of the father of the bride, says: 'This sword is a pledge of betrothal; take it and worship. Do thou pray to the goddess of fire.' Then, having received the sword, he worships the fire, saying: 'We have here and now settled to marry our son and daughter; therefore, O thou goddess of fire, hear thou and be witness thereto. Keep this couple from sickness and watch over them till they grow old.' The bridegroom's father then receives the sword and worships in like manner."[41]

An excellent account of the Hindu marriage fire is appended in full:

"The Marriage Fire (Vivahahoma). The bridegroom has to hold the bride, to conduct her hand-in-hand to the Vedi or altar prepared for the sacred fire. He has then to sit on a low stool facing the east. The priest tells the bride to pass by the west of the altar, to ascend it by the north, and to sit to the right of the bridegroom. The Sutrakars say after thus ascending the altar the bride must not speak (Sanskrit Niyamit vacham vadhumanya). But this restriction naturally forces itself on the girl, as she is by custom or etiquette quite silent during the whole process out of modesty. The bridegroom begins by sipping the sacred water twice and then mentioning the country and the time of the worship. He offers an oblation which means 'In order to attain for the bride just given to me the position of a wife duly married, and to prepare the "homa" fire, I do prepare this marriage fire,' beginning with the preparation of the receptacle and ending with the installation of the god of fire. Near the clay receptacle and to its west is placed a slab used for preparing sandalwood paste, to the northeast is placed a kalish or waterpot full up to the brim over a heap of rice covered over with mango leaves, and a coconut. It is decorated with red powder, sandalwood paste, and flowers. To the north of the fireplace are placed seven pinchfuls of rice running east to west. The bridegroom then holds in his hand a couple of the samidhas or fagots (taken from sacred trees) and recites the mantras, including the mention of his country, and the time, etc., of the performance, and a general offer-giving incantation. It includes the thrice repetition of the ceremonies under contemplation, such as (1) igniting the fire thrice; (2) offering ghi to Agni, the god of fire, and Prajapati, the creator; then (3) offering parched rice to Aryamagni, Varunagni, Pushpagni, Prajapati, and Svishttra Kritagni with the remnants. To the north of the fireplace is kept ready a winnowing horseshoe-shaped basket containing parched rice (lahya), and ghi forms an important item. It has to be heated and ceremoniously sprinkled over the parched rice thrice over. As soon as the preparations are over the bride is asked to touch the right hand of the bridegroom to signify her taking part in the ceremony, and the bridegroom is made to ignite first the adhar-homa, accessory fire, and then the chief fire, and then, accompanied by incantations or mantras, such as, '(*a*) Old sacred fire! The protector of our life! Pray give us food and power, and kill the Rakshasas that annoy us even before they reach us. (*b*) We both ask for wealth from the Pavaman fire, who is the fulfiller of the desires of the Brahman, Kshatriya, Vaishya, Sudra, and Antyaja (untouchable) tribes, who is omniscient, who purifies everybody, who has been placed in front by the Ritvijas, and who is praised by gods. (*c*) O Agni! You are a benefactor. Pray endow us with valour and lustre and sons along with cows and buffaloes. (*d*) O devourer of sacrifices! As you are the Aryama or the giver of the girl, as you are the holder of the name Vaishvanar, unintelligible to those who are ignorant of the Vedas, and, O Aryamagni! As it is you who make the bride and bridegroom work amicably together, and as therefore you are their benefactor or friend, therefore you are thus enthroned and fed with ghi and other offerings.'

---

[40] M. A. Czaplicka. Aboriginal Siberia. A Study in Social Anthropology. Clarendon Press, Oxford, 1924.

[41] Idem, p. 103.

"After the worship of the fire with the Vedic mantras the bridegroom is made to stand in front of the bride facing west. He is called upon to hold in his hand the open hand of the bride with the palm upwards. He is asked to grasp it along with the fingers and to recite a mantra meaning 'Lady! you are about to make me your husband, to live with me until we grow old, and therefore in order to propitiate your married state I thus hold your hand. You have been lawfully handed over to me by gods—Bhang, Aryama, Savitu, and Pusha—in order to perform the duties of a pair of householders.' Then the bride and bridegroom resume their seats. The bride is then asked to stand again, to wash her hands, and to hold them together to make a hollow. A little ghi is sprinkled over the palms. Her brother comes forward and puts into the hollow two handfuls of the parched rice. The bridegroom is made to sprinkle ghi over them. The bridegroom has to repeat the mantra 'Aryaman-nudevam,' etc., and while doing so to hold with both the hands the hollow formed by the bride and to make her pour the parched rice into the sacred fire. The mantra means: 'The bright sacred fire called Arayama, who has been satisfied with offerings by many brides, may be (personified) reduce the affections the bride bears unto her father, mother, brothers, and others, and release her from her gotra, and may he direct her affections toward my mother, father and brothers; may he increase the affection by degrees, and may he infuse into her the spirit of love, fidelity, and chastity toward me without ever discarding my Kula family.' The bride has next to stand behind the bridegroom, and to pass her hands in front of him as if in embrace, to go round the fire with him, the husband reciting another mantra meaning: 'O lady! I am like the Sama-veda and you are like the Rid-veda. I am like the sky and you are like the earth. We both in the presence of this sacred fire and these Brahams will marry each other, procreate children and endear ourselves to each other by good behaviour, and will live happily together for 100 years.' The bride is then asked to stand on the stone; while she is doing so the bridegroom recites another mantra which says: 'O bride! Do ascend this stone and let yourself be as firm in mind as the stone itself. Conquer your enemies by good deeds. Another offering of the parched rice follows, and another ascent to the stone is performed, repeating the process thrice; finally the bridegroom has to hold the winnowing basket with its open face or the horns of its horseshoe-shaped rim toward him, and to pour the remnants into the fire saying 'Prajapataiswha' etc.

"The brother of the bride touches the right ear of the bridegroom possibly to remind him that he is forgotten, and he is honoured with a turban."[42]

ORIGIN MYTHS

No origin myths yield so much of interest as those relating to the manner in which fire came to man. Endless outlines of vivid dramas of events through which fire became the valued possession of man are seen in the origin myths. Few of them are tame.

The differences existing between the myths of peoples form an interesting field for conjecture. If we assume that myths are in a constant state of flux, meaning social, political, and culture changes, then we can say that America and Africa and Oceania show less change and a more uniform development than Europe and Asia. An estimate may be made of the myth-forming ability of the peoples in the grand divisions of the world based on fire myths.

American Indian. Practical, logical. Conservative of cause. Medium grade of imagination.

Polynesia and Oceania. Mythopoetical, dealing in cosmic episodes. Inventive.

Asiatic. Civilized, highly imaginative and coherent. Uncivilized, crude.

Africa. Lack perspective; original, crude; ancient, illogical, imaginative.

---

[42] A Prabhu Marriage, by Rai Bahadur B. A. Gupte, 1911. Calcutta: Superintendent Government Printing, India, pp. 41–44.

European. Mythopoetic, imaginative. Folk, imaginative, but not much invention.

Throughout the world there appears a similarity in episodes forming the fire-origin story. The difference between the classic Greek and the lowly Ute is the polish of progress. Prometheus steals fire from heaven and Coyote steals it from an old woman. Which is the older myth? The answer may be that they are equally old and arrive at different places and degrees of culture from some common focus where the myth can be translated into terms of actual happenings. It is evident that the best types of fire myths are accretions, reflecting culture development. This is shown by the classification of North American fire myths following. As a preliminary statement, American fire myths have the advantage of the isolation of the new continent and have not been subjected to the dislocations effected by the movement of peoples in the Old World since the earliest times.

ANALYSIS OF FIRE MYTHS

Order	Methods
1. Preservational.	Perhaps refers to the earliest stage of use of fire.
2. Raptorical.	Seems to presuppose the knowledge of fire. Naive clew of soot and preparation of tinder among Ute and Pahonicki Miwok. Also loss and recovery.
3. Causational myths.	Early philosophy dealing with origins, sometimes observational generalizations. Probably later developments.
5. Benefaction myths	Culture heroes giving fire direct (preservational) or teaching method of making fire artificially (artifactural).
6. Renewal myths.	Opening up the immense field of fire customs, demonstrating man's attitude to fire.

Critical examination of the myths shows that many of them are accretions on some basic feature, as the acquisition of fire, and the additions follow a natural sequence. The philosophic element is doubtless later, undoubtedly added at a more mature period.

An analysis of a complete myth shows first the stealing of fire with all its exciting episodes, and naive philosophy explains how at that time fire was placed in various substances. This period would correspond to the stage of preservation of fire, when naturally some groups would have fire and others would not. It is so with all arts which have in ancient times been kept in secret. In this class many of the myths introduce the episode of the loss of fire by theft or accident and the struggle to regain it, often introducing the artifactural element promoted by the exigency. There appears to be no question that fire myths exibit the primitive zest of achievement, the joy of successful theft, the exhibition of endurance, cunning, and resource, observed on several cycles, as Jack the clever thief, and others.

Next we have fire made artificially from wood or other substances in which it was implanted. This represents the long period during which early man perfected the invention of the fire drill and strike-a-light of flint and pyrites. No philosophy is offered here, but there arise supernatural beings or culture heroes swathed in mystery who sometimes contribute direct the fire drill or strike-a-light, according to local usage.

Outlines of examples of myths of the various classes may be given. These are specimens selected from perhaps a hundred examples occurring in North American tribes.

I. PRESERVATIONAL MYTHS

This myth is found in great purity among the Tillamooks. With it is found the customary episode of loss of fire and fire stealing.

a. Older type of myth based on preservation of fire and loss by theft.

b. Newer type of myth based on preservation, loss through carelessness or neglect, recovery by invention of fire drill.

Fire origin, Menomini, Wisconsin.

"The Thunderers were also the makers of fire, having first received it from Manabush, who had stolen it from an old man dwelling on an island in the middle of a great lake."

"After this union the Bear built a long wigwam, extending north and south and a fire was kindled by the Thunderers in the middle. From this all the families receive fire, which is carried to them by one of the Thunderers, and when the people travel the Thunderers go on ahead to a camping place and start the fire to be used by all." [43]

2. RAPTORICAL MYTHS

The *dramatis personae* are animals or culture heroes, or these in combination, many always being the beneficiaries. This myth often includes preservation of fire, location of fire, and processes of securing it. Several South American examples of this type have been collected by Erland Nordenskijold and recorded in his work on Indian life. The theft episode is almost universal.

Dr. C. Hart Merrian says that the Mewan tribes of central California believed in "the existence at a great distance of a primordial heat and light giving substance indifferently called fire, sun, or morning, for in the early myths these were considered identical, or at least interconvertible.

The presence of a keeper or guardian of the fire, it being foreseen by its first possessors that because of its priceless value efforts would be made to steal it. The theft of fire, which in all cases was stolen from people or divinities living at a great distance. The preservation of this stolen fire by implanting it in the "*oo noo*" or buckeye tree, where it was and still is accessible to all. The power of certain personages or divinities as Ki lok, the North Giant, Sah te, the Weasel man, and O-wah to, the Bigheaded Lizard, to use fire as a weapon by sending it to pursue and overwhelm their enemies." [44]

---

[43] W. J. Hoffman. The Menomini Indians, 14th (pt. 1) Ann. Rept., Bur. Amer. Ethnol., 1892, pp. 0, 41.

The Maidu fire myth recounts that after the people had found fire Thunder seized it away from them and kept it for himself under the care of a little bird. The people were thus compelled to resume the conditions of primitive times, but succeeded in stealing the fire by strategy of Mouse, Deer, Dog, Coyote, and Skunk. The Mouse crept in Thunder's lodge, placed fire in a flute, a portion in Dog's ear, and some on the hock of deer's leg, and raced back pursued by Thunder.[45]

Beaver and Eagle had a sister who wept because she had no fire. Brothers trained four years and journeyed to the house of the people who possessed fire. (House said to be underground, near the sea.) Put on beaver and eagle skin. Beaver made a dam and tunnel under the house. They shot him and were skinning him when they saw an eagle. Went to shoot it and Beaver escaped with fire in a clamshell.[46]

3. ARTIFACTURAL MYTHS

This myth is comparatively rare, the myths of acquisition and preservation preponderating. The tale of the fire keeper carelessly letting the fire go out and in desperation inventing the wood frictional apparatus is ingenious, but is probably of recent invention.

The fire-origin myth of the Eskimo of Kegitareik is as follows: After the creation of the coast men, who were born from a bean pod, Raven taught them how to live. "He taught them how to make a fire drill and bow from a piece of dry wood and a cord, taking the wood from the bushes and small trees he had caused to grow in hollows and sheltered places on the hillsides." He returned then and taught the first man who lived inland "to make fire with the fire drill and place the spark of tinder in a bunch of dry grass and wave it about until it blazed, and then to place dry wood upon it." Also to roast fish on a stick.[47]

The Cheyenne Indians have the following fire-origin legend: "Thunder turned to Sweet Root Standing and said 'Get a stick; I will teach you something by which the people can warm themselves, can cook food, and with which they can burn things.' When Sweet Root had brought the stick he said, 'Rest the point of the stick in the middle of the (buffalo) chip and hold it between your hands.' When Sweet Root had done this Thunder said, 'Rub it between your hands and twirl it fast.' Sweet Root did so a few times and the chip caught fire."[48]

---

[44] The Dawn of the World. Cleveland, 1910, pp. 18, 19.

[45] R. B. Dixon. Maidu Myths. Bull. Amer. Mus. Nat. Hist., vol. 17, pt. 2, New York, June 30, 1902, pp. 65–67. Compare Curtin, Creation Myths, p. 365, Boston, 1898, and Kroeber, Utes Tales, Journ. Amer. Folk-Lore, vol. 14, 1901, p. 252.

[46] J. Teit. Traditions of the Lillooet Indians of British Columbia, Journ. Amer. Folk-Lore, vol. 25, October–December, 1912, pp. 299–300.

[47] E. W. Nelson. The Eskimo About Bering Strait, 18th Ann. Rept., Bur. Amer. Ethnol., 1900, p. 456.

A fire myth of the Mohave Indians relates that: "The Blue Fly learned the art of rubbing fire out of sticks." (Observation on flies twirling their legs?)[49]

4. CAUSATIONAL MYTHS

A class of myths cognate with those explaining the origin of things and which relate the supernatural way in which fire was implanted in substances from which it may be elicited by man.

A fire myth of the Fox Indians assigns the source to supernatural beings: "Our fire comes from the manitous who live in the world under the earth. They created the fire and it is theirs. All their time they spend watching after and caring for it. The fire that people use first came from this place under the earth. Even the Thunderers who keep watch over the people obtain their fire from the manitous of the underworld. This is the fire one sees flashing from their mouths as they pass across the sky."[50]

A Teton Sioux song frequently used as opening song of the Sioux Ghost Dance concerns the origin of fire:

"It was the father who gave us these things,
It was the father who gave us these things,
It was the father who gave us fire,
It was the father who gave us fire,
The father gave it to us,
The father gave it to us."[51]

The Menomini Indians of Wisconsin have a rather involved myth which is of the causational type. It relates that "the daughter of Nokomis, the Earth, is the mother of Manabush, who is also the fire. The Flint grew up out of Nokomis and was alone. Then the Flint made a bowl and dipped it into the earth; slowly the bowlful of earth became blood, and it began to change its form. So the blood was changed to Wabus, the rabbit. The rabbit grew into human form, and in time became a man, and thus was Manabush[52] formed. Manabush was angry because he was alone on the earth, and because his enemies, the An a maq kiu, who dwelt beneath the earth were constantly annoying him and trying to destroy him."[53]

---

[48] G. B. Grinnell. Some Early Cheyenne Tales, Journ. Amer. Folk-Lore, vol. 20, July-September 1907, p. 171.

[49] J. G. Bourke, in Journ. Amer. Folk-Lore, vol. 2, July–September, 1889, p. 189.

[50] William Jones, Notes on the Fox Indians, Journ. Amer. Folk-Lore, vol. 24, April–June, 1911, p. 214.

[51] James Mooney. The Ghost Dance Religion, 14th (pt. 1) Ann. Rept., Bur. Amer. Ethnol., p. 1070.

[52] Masha great, and wabus, rabbit.

[53] W. J. Hoffman. The Menomini Indians, 14th (pt. 2) Ann. Rept., Bur. Amer. Ethnol., 1892, p. 87.

5. BENEFACTION MYTHS

This type of myth attributes fire as the voluntary gift of beings or culture heroes. It is frequently accompanied with causational, preservational, and artifactural episodes.

The Uintah Utes say: "Coyote caught fire and gave it to the Indians. The Indians kept the fire and never lost it again. It made light and heat. It was cold; and if there had been no fire the Indians would all have died. The fire kept them alive. Coyote said, 'It is very good to do that.' He gave life to the Indians. Perhaps Coyote got the fire from the white men in the east."[54]

The Lillooet Indians have a myth embracing light origin and fire origin. It states that Sea Gull owned daylight and kept it in a box. Raven got him to open box and broke box, letting daylight escape. Raven saw smoke in south, embarked in a canoe and came to house of fire people. Stole baby and escaped. Traded baby back for fire. The fish people showed Raven how to make fire with dry cottonwood roots. Thereafter Raven sold fire to every family who wished it, and became possessed of many wives in payment.[55]

6. RENEWAL MYTHS

James Mooney states that in the Ghost Dance religion a message was received from the gods to renew and preserve fire. The renewal idea was general in Mexico and extended to other cult practices. It follows, of course, the invention of fire making, as experience always precedes myth formation.[56]

From our present knowledge of fire-origin myths among the tribes south of Mexico it appears that as we move southward the basic myth, so clear in North America, has faded out gradually among the tribes of South America. There is a lack of observations on the natives, but what is found seems to bear out the assertion.

The Bribri and Brunka Indians of Costa Rica have genesis myths in which gods utilize fire to roast and boil chocolate. No gift of fire to man is incorporated.[57]

Ehrenreich says that it is strange that but three fire myths are known from South America, and they exhibit quite different traits, but all have parallels in North America.

Fire myths, he says, have had but slight consideration in South America. In three places only have they been collected, and but superficially explained. The shining eye of the camp fox, according to the Bokairi tale, concealed the fire which was struck out by Keri. The Tupi myth is based on the conception common in North America that animals marked by black have been burned by fire, and such animals bring fire, or at least are its original possessors from which the culture heroes get it. As in North America and Mexico, the deer brings the fire and at the same time burns away his tail. So among the Tupi the sloth gets the black spot on his back, indicating the place from which the twins took the fire. Among the Kaingang the fire was abducted by some higher being, and in a manner recalling the conceptions of the northwestern American Indians. A hero transforms himself into a magpie, which gets possession of a glowing coal at the fireplace of the sun.[58]

---

[54] J. Alden Mason. Myths of the Uintah Utes, Journ. Amer. Folk-Lore, vol. 23, July-September, 1910, pp. 362-363.

[55] J. Teit. Traditions of the Lillooet Indians of British Columbia, Journ. Amer. Folk-Lore, vol. 52, October-December, 1912, pp. 300-303.

[56] The above extract from American fire-origin myths is from a paper by the author on American Indian fire-origin myths read before the twentieth International Congress of Americanists at Rio de Janeiro, Brazil, August, 1923.

[57] H. Pittier di Fabrega. Folk Lore of the Bribri and Brunka Indians, Journ. Amer. Folk-Lore, vol. 16, January-March, 1903, pp. 1-9.

The Mataco, Chanes, Chiriguanos, and Tapiete of the Gran Chaco include in their fire-origin myths the episode of fire theft, and the two former include an episode of great fire.[59]

In view of the large body of literature on European myths and folklore, the work of students of the subject gathering for centuries, it is not necessary to present a treatment here. The scientific study of mythology had its birth in Europe, and all investigators are indebted to the men who founded the science.

It is true, as, notably among other writers, Andrew Lang points out, that classical myths descend with very little dislocation from crude early ideas. We have in Prometheus the extension of the early almost universal episode of the theft of fire and punishment for the immorality of taking fire by stealth from the fireplace of the family of the gods.

Investigations of classic mythology represent work in the upper layer of European folklore. Other numerous strata are hardly distinguishable. On the decay of classicism and in the rebuilding of European culture the mythology of a number of nations which had been submerged came into prominence. This body of myth and folklore not only is well recorded and studied, but furnishes the literary background which has made European literature preeminent.

The fire myths of Oceania present striking examples of the mythopoetic faculty of many of the island races, particularly those of the Polynesians. Dr. Roland B. Dixon considers these myths in many respects unique and of Oceanic development.[60] He divides the myths into evolutionary or genealogical and creative acts of deities. A good example from the Maori of New Zealand is appended.

The Maori say that fire was derived from the five children born of the Dawn Maid and Mahiuka and named for the five fingers of the hand. The secondary myth makes Maui beg the finger of Mauika to produce fire for man. The myth connects the five fingers of man in fire making with the production of fire. Auahi roa, the comet, brought fire, and fire is called Upoko roa, son of Auahi roa, the comet which first brought it to man. The descent of the fire is as follows:

---

[58] Dr. Paul Ehrenreich. Die Mythen und Legenden der Sudamerikanischen Urvolken, Berlin, 1905, pp. 17 and 57.

[59] Erland Nordenskijold. Indianlif i El Gran Chaco. Stockholm, 1910.

[60] Roland. B. Dixon. Oceanic Mythology. Mythology of All Peoples, vol. 9, Boston, 1916, p. 307.

Te-ra, The sun.
Auahi-truva, Mahuika.

Takonue Takoroa Mapere Manawa Toiti.[61]

The following myth presents episodes like those of America:

"The descendants of Tarangate were the parents of Fire. He conceived the idea that he was destined to become the conqueror of the world. He protruded his tongue to lick up water, thinking he could consume it all. Then came forth the great wave to do battle with him. The one shot forth his tongue, the other did the same on his part. Aha! The name of the battle was Kaukau-a-wai. Then water invoked all the winds, every one of them; they came forth; then, indeed, was the power of water exhibited. Aha! This was the defeat of fire; it flew; it retreated; it was conquered by water Before all was over, however, everything on earth had been melted by the heat. After the conquest by water the few remains of fire flew into the rocks, and also into the trees, especially into the Kaikomako tree. Behold the mountains such as Raupehu and others, which ever burn, ever rage.

"Toitipu and Manatu were the men who discovered the hiding place of the fire within the trees, that is, the remnants which escaped there after the conquest by water. So they sought for means by which fire could be obtained for the use of man, and experimented with wood, one holding the board (or piece held flat on the ground) whilst the other rubbed a stick on the surface. After a long time forth burst the smoke; hence the saying, 'By energetic rubbing with the hand the son of Opoko-roa shall appear.'

"After this the two made a snare; great was the thickness of the ropes thereof! Was it not to catch Matuku? Matuku was an exceedingly evil being—indeed, he was a very Taniwha—who lived in a cave. They found a tree suited to their purposes, over which they cast a rope, which caught in a fork; then they hauled on the rope till the tree bent down, and to it they fastened the snare, and thus completed their work. They then ascended a hillock, a ridge which stood near there, and lit a fire. No sooner did Matuku see the smoke of the fire than he rushed out of his cave, and, seeing the two men, immediately drew toward them, when he suddenly encountered the snare. His head was soon within it, and he commenced to struggle whilst the two men looked on. Before long he trod right on the spring, when suddenly up sprung the tree, tightening the rope. Then Matuku struggled! Struggled in vain!"[62]

---

[61] Elsdon Best. Astronomical Knowledge of the Maori. Dominion Monograph 3, Wellington, 1922, p. 54.

Another form given here in synthesis is from Hawaii. It is simple and more like American Indian myths.

Maui obtains the secret of fire, before only known to the mud hen. Delays the rapid course of the sun by breaking off the rays, which are spines like those on a sea urchin.[63]

The Tongatabu fire myth approaches closely the benefaction myths of the American Indian.

Kyskys obtained some fire from the earth and taught them to cook their food, which they found was good, and from that day food has been cooked, which before was eaten raw. In order to preserve the fire Kyskys commanded it to go into certain trees, whence it is now obtained by friction.[64]

The Aryan fire-origin myth states that Agni was son of the carpenter who made the drill and Maya or magic. He took the name of Aksa, anointed, and when nourished by libations of butter he attained full development.

There is here an example of extreme sophistication. It is probably not the real myth, but rather an explanation to be given to the uninitiated. Its philosophy is based on the engendering of fire by wood friction, and corresponds to the Finnic fire-origin myth in the Kalevala. In contrast a Ceylonese fire-origin myth shows a delightful return to nature.

"The story current about the blue-black swallow-tailed flycatcher, *Kwandu panikkia*, and its mortal enemy, the crow, is that the former, like Prometheus of old, brought down fire from heaven for the benefit of man. The crow, jealous of the honor, dipped his wings in water and shook the drippings over the flame, quenching it. Since that time there has been deadly enmity between the birds."[65]

Among the African myths there is a curious example from the A-Kamba Tribe, East Africa:

"There is a legend that the first human being of earth was half man and half woman. He was called Mukuu and lived in Kikumbuliu district near a hill called I-Kuua. He brought fire with him to this earth and was the father and mother of mankind. His progeny found the various food plants growing wild in the valleys, and they did not know at first how to plant or cultivate the soil."[66]

---

[62] Hare Hongi. Journ. Polyn. Soc., vol. 3, No. 3, pp. 155-156.

[63] N. B. Emerson. Journ. Amer. Folk-Lore, vol. 12, July-September, 1899, p. 233.

[64] Wilkes Explorations, vol 3, p. 23. See also for many interesting myths, Edward Tregear. The Maori Race. Wanganui, N. Z., 1904.

[65] Nature, vol. 36, p. 87.

[66] C. W. Hobley. A-Kamba and Other East African Tribes, p.51, London, 1910.

The following myth was collected from the southern Bantu:

"In the Ronga clans these two ancestors of mankind are called Likala Humba and Nsilambowa. The first name means the one who brought a glowing cinder in a shell, viz, the originator of fire. (Compare the Hlengwe tradition, vol. 1, p. 23.) Nsilambowa, the name of the woman, means the one who grinds vegetables. The first human beings, according to these names, would have been those who introduced fire and the culinary art into the world! This idea is interesting, and seems to show that for the native mind the cooking of food is the pursuit which differentiates man from the animals."[67]

COMMUNAL FIRE AND SOCIAL ORGANIZATION

The rôle played by fire in the development of the artificial social organization has been given great attention by many writers. The thesis is briefly that the care of the fire was exiguous in earliest times, and therefore enforced the delegation of an individual to its service. Thus the first delegated office, that of fire keeper, had its inception. From this beginning are traced institutions and the governing fabric of society. It will be seen that on the introduction of this new social element based on fire there would begin to run along together the natural development springing from social instincts and the unifying tendency growing out of the use of fire in common.

Theories of primitive social integration provide for a communal fire. Logically, in view of the limitations surrounding the first fire, possession should be in common to whatever type of human grouping obtained at the time. It is seen that the division of fire must necessarily have taken place very soon, followed by the endless use of fire for special purposes, and the separation into sacred and profane fire must have been an early generalization. Some considerations on the static effect of fire on early populations and on migrations are given in the work cited below.[68]

The communal fire, which remained a simple custom in many instances among the lower grades of culture, developed into the classical politico-religious hearths or alters of Greece and Rome familiar as the prytaneum and temple of Vesta.[69] Mr. Frazer clearly accomplishes the task set at the beginning of his paper: "The object of this paper is to prove the common origin of the Greek prytaneum and the Italian temple of Vesta, and to suggest an explanation of the origin of the order of the vestals as well as of the custom of maintaining perpetual fires" (p. 145).

These survivals which are noted under fire preservation are thought to hark back to the time when fire was not only carefully preserved and attended, but formed a nucleus around which the human group gathered. This stage is called the tribal or communal fire, and from the tribal fire is supposed to have descended the family fire, which has survived in the customs surrounding the perpetuation of this fire.

---

[67] H. A. Junod. The Life of a South African Tribe, vol. 2, p. 327, Neuchatel, 1913.

[68] Walter Hough. The Distribution of Man in Relation to the Invention of Fire-Making Methods, Amer. Anthrop., new ser., vol. 18, 1916, pp. 257-263.

[69] J. G. Frazer. The Prytaneum, the Temple of Vesta. Perpetual Fires. Journ. of Philology, vol. 14, pp. 145-172. London, 1885.

Most of the studies of this subject in dealing with the primitive period are compelled to make use of the scientific imagination, an important aid if judiciously applied. In general the theory of the effect of fire on the development of social features is acceptable as reflecting the present state of thought on the subject. This theory is based on a later stage, when social forms have crystallized and a considerable survival of customs offer what seems to be good grounds for deductions. Criticism is offered that there is a tendency to attribute too much to fire and to omit other developmental germs which antedate fire.

BORROWING

There were good reasons for using the word borrowing in respect to fire. Fire was property of a particular class, and could not be sequestrated by gift but could be loaned. It was a violation of primitive morals both to ask for the gift of a portion or to give a portion. Speech has preserved the idea, though the meaning is lost when one man asks another, "May I borrow a light?" The Hopi Indian understands it, however, when he asks for "some of your fire." There is much data to show that this custom harks back to the time when the house fire was regarded as sacred and the life and well-being of the family were involved in its care and worship. At some early period superstition regarding the house fire was intense. The formality of borrowing fire was a cautious negotiation and the theft of fire punishable with death, probably in primitive law extending to the offending family. A superstition of such weight could not fail to survive into periods when ancient beliefs had been softened into outworn customs; nevertheless the sacredness of the house fire is maintained in many parts of the world, even as islands amongst the high civilizations of to-day.

Montaigne makes an apt illustration from the custom of borrowing fire. "Wee may verie well be compared unto him, who having need of fire, should goe fetch some at his neighbor's chimney, where finding a goof fire should there stay to warme himselfe, forgetting to carrie some home." [70]

In Pennsylvania when one comes in a great hurry it is customary to ask, "Did you come for fire?" This is a survival from an early period when "fire borrowing" was common.

In the United States National Museum is a small pair of bronze tongs with basket head. These were brought from Denmark in 1792, and were the property of the Muller family, relatives of Hans Christian Anderson. They were used in borrowing fire to transport coals from one house to another. (See pl. 5, fig. 6.)

---

[70] Essays of Montaigne, Chap. 24, p. 278. London, 1889.

FIRE IN MORTUARY OBSERVANCES

The use of fire in mortuary observances is quite widespread. In this mass of practices is seen the immense hold fire has on the mind of man. The complex reveals innumerable philosophies, from the crudest to those of high spiritual concepts. From ancient times fire was thought to be the best agent known to man by which he could be allied to the spiritual world. It is recognized that these conceptions do not belong to the early periods, about which little may ever be known. No doubt, however, the germs of later ideas were present in the men first acquainted with fire. Some clues in historic and prehistoric periods may allow of the projection of science into the misty past. A similar large body of customs refer to light in mortuary observances, and will be treated under the appropriate heading.

Among the reasons advanced by Yarrow from his study of the question are purification of the soul, that demons would be driven away, and that the fire would give light for the journey and heat to cook food.[71]

Excavations in the ancient Pueblo cemeteries almost invariably show masses of charcoal and ashes appearing as a layer in the earth above the skeletons. In some cases ashes were placed with the bodies at the time of burial. So far as can be ascertained there is no present Pueblo custom by which the ancient custom can be checked up. Many excavations show that burials were made in village rubbish heaps in which ashes and charcoal are large components, and in this case it is not always possible to trace the definite use of charcoal and ashes as in undisturbed earth. In reconstructing the custom recourse may be had to the grave fire of several Indian tribes. It is presumed that at the time of ancient Pueblo interments a fire was built near the grave and the ashes and charcoal thrown in as the excavation was being filled.

The custom of burning the belongings with the dead has wide extension areally and in time. Some idea of sacrifice inheres in the custom, and also that of transmitting the things burnt to the spiritual world. This custom is often connected with cremation.

On the edge of Pennsylvania and Maryland Chief Lovell, head of the large gypsy "tribe" of that name, died. Mrs. Lovell had all his property burnt in regulation gypsy fashion.[72] This custom brought to our doors in recent times reflects some ancient rites to the dead, probably in the case mentioned arising in India.

---

[71] H. C. Yarrow. Mortuary Customs of the North American Indians, 1st Ann. Rept., Bur. Amer. Ethnol., 1879, p. 198.

[72] From a press item in 1900.

Cremation was practiced in the Bronze Age and also in the Iron Age, about half of the 1,000 tombs excavated at Hallstatt being cremation interments.

"My learned friend, Dr. Karl Blind, in his excellent pamphlet entitled 'Fire Burial,' cites the Odin law in Scandinavia, which reads as follows: 'Odin ordained that the dead should be burnt, and that everything that had been theirs should be carried to the pyre. He said that every one should go up to Walhalla with as many riches as would be heaped upon his pyre, and that he should enjoy in Walhalla all those things also which he had hidden away in the earth. The ashes should be thrown into the sea or be buried deep in the soil; but for illustrious men a mound should be raised as a token of remembrance.'

"Dr. Blind also gives in the same pamphlet the description of Beowulf's funeral, to prove that it was also the habit with the Anglo-Saxons to burn their dead with treasures:

" 'Geatland's men for him then made
A pyre broad, most firmly built,
With helms bedeckt, with war-shield hung,
And armour bright, as he them bade.
In the midst they laid, the sorrowing heroes,
Their mightly ruler, their beloved lord.'

"Thus we have the proof that in a remote antiquity it was the custom in Babylon, Egypt, Italy, Macedonia, Scandinavia, and Germany to bury the rich with their treasures, and my excavations have proved that this custom existed also at Mycenae in the time of the Atridae."[73]

In accord with some idea of providing for the spirit may be noted the ancient Chinese custom of placing funerary stoves with the dead.[74] These have been found dating from the Han dynasty, about 2,000 years ago, and present perhaps the earliest specimens of stoves of the brazier type yet recovered.

CREMATION

"They burnt a corpse upon the sand—
  The light shone out afar;
It guided home the plunging boats
  That beat from Zanzibar.
Spirit of Fire, where'er thy altars rise,
Thou art Light of Guidance to our eyes."

—*Salsette Boat Song.*

Heading to "In Error." Plain Tales from the Hills. R. Kipling.

---

[73] Henry Schliemann. Mycenae. New York, 1878, p. 349.

[74] B. Laufer. Chinese Pottery of the Han Dynasty. Brill, Leiden, 1909. J. J. De Groot. The Religious System of China, Brill, Leyden, 1892, p. 25.

The most outstanding mortuary fire custom is cremation. The custom is widely but irregularly distributed, and appears at all grades of culture. The reason, place, and time in respect to its origin are conjectural. It is surmised that it refers to the idea of purification involved in the worship of fire. A deeper idea may be that of the transference of the spirit at once to the gods in the manner of incense. Still another idea could be the feeding of the gods, like burnt offerings, or with blood, as in the strengthening of the spirits for the interview of Odysseus in hades.

As an important and perhaps the chief cause for the custom of cremation of the dead may be suggested, the desire to remove the house of the ghost or perhaps by the power of fire to destroy the ghost. A like instance is observed in the custom of some of the tribes of Siberia in cutting many incisions in the body of the dead for the presumed purpose of rendering the earthly tenement uninhabitable by the ghost.

It is plain that the matter is quite complex and may never reach a satisfactory elucidation. Modern cremation is alleged to rest on a sanitary basis, but insensibly there must remain the traces of the ancient custom.

"But the most remarkable celebration I attended while in Billigam [Ceylon] was the burial of an aged Buddha priest on the 13th of January. While the common people here are simply buried (in the gardens behind their houses, or in the nearest cocoa grove), the priests alone share the honor of being consumed by fire. The priest to be burned on this occasion was the oldest and most distinguished in the community. Accordingly, the funeral pyre of palm stems was erected near the principal temple. After the body, which rested on a flower-adorned bier, had been carried amid solemn chanting through the village, a band of young Buddha priests in yellow robes hoisted it to the top of a funeral pile which was about 30 feet high. The four corners of the pyre were supported by four cocoa palms between which was stretched a canopy like a large white cloth. After the conclusion of various ceremonies, solemn dirges, and prayer, the pile at 5 o'clock was lighted amidst a most deafening tom-tom uproar. A crowd of several thousand people watched the burning pile with expectant interest, and when the flames seized and devoured the muslin canopy, a loud, jubilant cry went up from every throat—the soul of the burning priest had taken its flight to heaven. This was the signal for inauguration of more cheerful ceremonies. Rice, cakes, and palm wine were distributed among the crowd, and a merry carousal followed that was kept up around the burning pyre the greater part of the night."[75]

---

[75] Ernst Haeckel. India and Ceylon, New York, 1893, p. 153.

In prehistoric America cremation was practiced in a number of localities. The so-called mound builder culture has revealed evidences of its use. What were thought to be altars, platforms consisting of a mass of baked white clay found in mounds, are now known to be hearths for cremation. Such hearths are found principally in Ohio and Illinois.[76]

The disposition of the ashes is not known, but the inference is that they were scattered. Among the ancient Pueblos who practiced cremation the ashes were preserved in vases generally, but the cliff dwellers made some other disposition of them.[77]

The prehistoric peoples of the lower Gila and Salt Rivers in Arizona placed the ashes in pottery vases.[78]

In the Forestdale ruin, upper Salt River, Arizona, the writer found instances of full-length burial and cremation on the same site. The practice of cremation is similarly unequally distributed in the Pueblo region and has little comparative value in ethnology. Clarence B. Moore has brought together what is known on cremation in ancient America, and the reader is referred to his work.[79]

It was the habit of several California tribes (Yuma, Pomo, etc.) to burn with the dead his belongings and whatever offering would be made by relatives and friends. Historic instances are confined to some tribes of the far Southwest and West.

The Haida Indians of Queen Charlotte Islands, British Columbia, cremated the bodies of the dead dying away from home. The Haida were said to burn the body to keep the enemy from making charms with it to destroy the tribe.[80]

ORDEAL

Ordeal in general is a primitive substitute for law. In the ordeal by fire it is a reference of a case to the magic power of this institution, whose mysterious properties, not of this world, shall by burning or not burning adjudicate the cause. It is a form of divination by which the will of the superior powers is made known through an agency thought infallible. It will be seen that there are voluntary and involuntary types of ordeals, the first being a test of courage or proof of righteousness and the second required by the sense of community or law. The system of fire ordeal was best developed in India, where at one time it had quite general currency. The custom goes back into antiquity, and many isolated instances of it are recorded. Zoroaster, Abraham, Shadrach, Mesach, and Abednego coming triumphantly through the fiery bath are instances of Old World ordeals. The Zuni twin sons of the sun were tried by fire to determine their parentage, though this episode may be accultural and it is probable that this type of ordeal does not belong to American indigenous lore.

---

[76] W. C. Mills. Exploration of the Mound City Group, vol. 3, Columbus, Ohio, 1922. C. C. Willoughby. Papers Peabody Museum, Cambridge, Mass., vol. 8, No. 3, 1922, p. 36.

[77] Walter Hough. The Museum-Gates Expedition. Ann. Rept., U. S. Nat. Mus., 1901.

[78] J. Walter Fewkes. Two Summers Work in the Ancient Pueblos, 22d Ann. Rept., Bur. Amer. Ethnol., 1903.

[79] Urn-Burial in the United States. Amer. Anthrop., new ser., vol. 6, October-December, 1904, p. 660. See also article Cremation in the Handbook of American Indians, Bull. 30, Bur. Amer. Ethnol., 1907.

[80] J. G. Swan. The Haidah Indians, Smith. Contr. to Knowl., No. 267, 1874, p. 9.

In the classical fire ordeal of the Hindus the procedure was as follows:

"1. Eight concentric circles of equal breadth are marked on a piece of ground.

"2. An iron ball is heated repeatedly by a blacksmith.

"3. The hands of the defendant are examined, and all existing sores or scars covered with dots.

"4. His hands are wrapped up in leaves, in order to protect them against the hot iron.[81]

"5. A prayer addressed to Agni, god of fire, shall be recited and written on a leaf which is fastened on the head of the defendant.

"6. The iron ball is placed in his hands, and he is made to walk slowly through all the circles successively, taking one circle with each step. On reaching the last circle he may throw the ball on the ground.

"7. His hands are examined once more. If they are found to contain any fresh sores or wounds he is guilty; if not he is innocent.

"8. If he lets the ball drop from fear before having reached the last circle, or if the examination of his hands has yielded no definite results, the whole proceeding has to be repeated.[82]

"It is, however, to be remembered that an accidental burn on any other part of the body does not count. To make quite sure that there has been no fresh sore or wound on the hand from the handling of the red-hot iron, the accused is given some unhusked rice, which he has to rub vigorously between his hands seven times to separate the grain from the husks."[83]

"In the trial by fire the accused in India walks barefoot into a heap of pipul leaves (*Ficus religiosa*); in Siam over a pit filled with burning charcoal. In the ordeal by boiling oil the accused has to thrust his hand into the scalding fluid.

"The hot-iron ordeal is practiced. Nine circles are drawn, each 16 fingers in diameter and each the same distance of 16 fingers apart. The hands of the accused rubbed with unhusked rice (paddy) and all marks are carefully noted. Seven pipul leaves are then bound with seven threads on each hand and the priest gives him a red-hot ball to carry as he steps from circle to circle, keeping his feet within each until he reaches the eighth, when he throws the ball on a heap of dry grass inside the ninth. If his hands, which are then examined, be not burned he is pronounced innocent.

---

[81] A. K. Forbes says in his Ras Mala that the leaves are those of the burr tree, as he had himself once seen this ordeal employed. The leaves usually protect the person from injury.

[82] Narada I, pp. 285-303. Quotations from Narada VI, pp. 36-49.

[83] Journ. Anthrop. Soc. Bombay, vol. 6, 1902, pp. 24-26.

"In Japan the reputed thief bears in his hand a piece of thin paper having the figures of three deities. On this a piece of red-hot iron is placed, and if his hand escapes he is pronounced free."[84]

In Tibet fire ordeal was an important feature of adjudication and several methods were practiced:

"In matters of importance they give judgment in two ways. One is by placing two stones, one white and the other black, in a vessel of boiling oil, and, without seeing, by causing one of the stones to be taken out by the hand. If the stone be white and the hand uninjured, that man is in the right, without the other party having to dip his hand; if, on the other hand, he first encounters the black stone, even if he does not injure his hand (for this ordeal they make use of a certain secret or magical art), he is adjudged liar, and the other must insert his hand likewise. The other method of giving judgment is to heat a long, round bar of iron, and when red hot to cause the hand to be drawn along the whole bar, and if the hand be not injured the right is on his side."[85]

The Greeks also practiced this ordeal. The accused had to creep through fire, or was given red-hot iron which he had to hold in his hands without discovering any sense of pain. In Antigone of Sophocles Creon is assured that all the guards were "ready for all commands,

Either red-hot bars to take up with our hands,
Or pass through fires, or by the gods to swear
That neither in the body did enter
Nor privy to the wicked action were."[86]

And the Emperor Theodore Lascaris of Nicea, attributing his sickness to magic, caused all those whom he suspected to handle the red-hot iron; thus joining, as has well been remarked, to the most dubious crime in the world the most dubious proof of innocence.[87]

The foregoing references are extracted from the Journal of the Anthropological Society of Bombay, 1902. (Vol. 6, No. 1, pp. 24–28.)

Fire tests and ordeals are quite uncommon in America and do not follow the Old World types, being rather like purifications. Witchcraft is thus tested among the Wyandot. "When the accused is adjudged guilty he may appeal to supernatural judgment. The test is by fire. A circular fire is built on the ground, through which the accused must run from east to west and from north to south. If no injury is received he is adjudged innocent; if he falls into the fire he is adjudged guilty."[88]

---

[84] Edward Balfour. Cyclopaedia of India, Madras, 1871, vol. 4, pp. 260–261.

[85] Horace della Penna in Narrative of the Mission of George Bogle, pp. 324–325.

[86] Antigone V. p. 270.

[87] Blackstone, p. 343.

The custom of war, or, describing it in terms of folklore, the ceremonial of war, is an old social practice. It had strongly at first and more obscurely to the present the idea of ordeal, practically a divinatory rite in which a decision should be to the side having the favor of the gods. Battle cries often declared this idea. The ordeals of single combat and gladiatorial combats are striking instances. Even games had the ordeal feature.

PURIFICATION

Among the customs which show the confidence of man in the supernatural properties of fire, purification by its means stands out prominently. The customs are the outcome of rude generalizations on the mysterious behavior of fire, its properties and effects, and the knowledge gained by experience.

Sia Indian hunters make the following invocation to fire: "Coyote spoke to the fire, saying 'we desire many rabbits but we do not wish to go far!' Before hunting the hunters passed their rabbit sticks through the flames."[89]

A similar smoke purification or incantation occurs in Burma, where the people and party and guns were passed through smoke before the hunt.[90]

A Bornean fire ceremony at the close of a Katingan funeral is described by Lumholtz: "I was about to leave when the people began to behave in a boisterous manner. Men caught firebrands and beat with them about the feet of the others. Some cut mats in pieces, ignited them, and struck with those. A woman came running out of the house with a piece of burning mat and beat me about my feet and ankles (my trousers and shoes were supposed to be white), and then went after others, all in good humor and laughingly. She next exchanged firebrands with a man, and both struck at each other repeatedly. This same custom is used at funerals with the Ot-Danums on the Samba, and the explanation given in both tribes is that the mourners want to forget their grief." [91] More likely the ceremony is for purification.

In Tartary Abel Remusat observed "a Tartar custom by which all newcomers at court, be they princes or envoys, and all presents they brought with them, were obliged to pass between two big fires; by so doing all evil influences or ill luck which they bore with them were driven away." [92]

---

[88] J. W. Powell. Wyandot Government, 1st. Ann. Rept., Bur. Amer. Ethnol., 1879–80, p. 67.

[89] Mrs. M. C. Stevenson. The Sia, 11 Ann. Rept., Bur. Amer. Ethnol, 1894, p. 65.

[90] C. P. Wolley. Big Game Shooting, vol. 1, p. 269, London, 1894.

[91] Carl Lumholtz. Through Central Borneo, vol. 2, New York, 1920, p. 320.

[92] Abel Remusat. Hist. des relations politiques primus, chretiens avec les Empereurs Mongol, in Mem. Acad. Insc. et Belles Lettres, New York, 1920, pp. 361–378.

Speaking of burkhans, images, from Lhasa, Sven Hedin says of the Mongols of Tsaidam: "Any person who stops to look at the latter must take his pipe out of his mouth, nor must he breathe upon them. When I inadvertently transgressed against this rule the burkhan was purified by being held over a brazier, into which fragrant spices were dropped. Nor are the holy images allowed to come in contact with the earth." [93]

Fire purification in Tibet was observed by Bonvalot and Prince Henri of Orleans: "A short time ago we saw the Thibetans pass our baggage over the fire so as to purify it before they put it on their shoulders, whilst on another occasion the men who were at work in the fields we went through snatched up a handful of earth, like Marius predicting the birth of the Gracchi, and, throwing it into the air, mumbled a form of prayer to disinfect the soil." [94]

Fire purification is frequent in birth customs. The Malagasy build a great fire at time of childbirth. Similar customs are found among the Burmese and Siamese, and the mother is exposed to heat." [95]

"Before the child is born a bright fire is kindled and kept burning for 10 days after the birth to keep away evil. At the end of the tenth day the parents carry the child to the river and all bathe. After that the fire is left to smoulder, but it is not put out entirely until the child is two years old." [96]

In ancient Greece, on the fifth day after the birth of a child the midwives, having purified their hands, ran with it round the hearth.[97]

The Persians jump over piles of blazing brushwood on New Year's Day.[98]

SUPERSTITIOUS HEALING

Under superstitious uses of fire in quasi healing there are innumerable examples appertaining to every race and time. Survivals of these customs are most persistent. There are as great number of practices of this kind extant to-day as there ever were, despite the advances of medical science.

These practices have as a foundation the idea of communicating the mystical properties of fire to the patient, to drive away by the superior power of fire the disease supposed to be present as a malevolent influence, or to introduce some beneficent property of fire. Moxa is often used in this way and was probably in its beginning of this character. Fire also is superstitiously used for collective healing or proctection from disease. This is well shown by the fire superstitions of the Yarchans of northern Siberia:

---

[93] Sven Hedin. Through Asia, vol. 2, p. 1080.

[94] Bonvalot. Across Thibet, New York, 1892, p. 381.

[95] C. Staniland Wake. Journ. Anthrop. Inst., vol. 11, 1881, p. 25.

[96] G. A. Dorsey. Caddo Customs of Childhood, Journ. Amer. Folk-Lore, vol. 18, July-September, 1905, p. 226.

[97] See Socrates' allusion to this custom in Theaetitus. Hooper's Translation, p. 429.

[98] For citation of many of these customs and their interpretation see Frazer's Golden Bough.

"A wood fire, that is, a fire that has been kindled by rubbing two sticks together, plays an important part as a prophylactic against infections and all kinds of diseases. When an epidemic breaks out the use of matches is forbidden, all fires are extinguished, and a new wood fire is kindled in the street, all the household fires must be replenished. If while this is going on any fire is lit by means of matches or flints, the procedure is vitiated and has to be gone over again from the beginning."[99] This opens up the great subject of new fire, considered separately.

The formulistic name for fire among the Cherokees of North Carolina is the Ancient White. "The name refers to its antiquity and light-giving properties, and perhaps to the fact that when dead it is covered with a coat of white ashes. In those formulas in which the hunter draws omens from the live coals it is frequently addressed as the Ancient Red. Four chips taken from the hearth fire and generally placed in an earthen vessel by the side of the patient furnish the fire used by the doctor for the treatment of neuralgia. A decoction is sometimes heated by putting into it seven live coals taken from the hearth fire."[1]

The efficacy of medicines is promoted by treatment by fire. It is the custom of the Eskimo of St. Lawrence Island, Alaska, to effect the healing by their various fetishes through the application of the fetish previously to fire, or to burn a small bit of the fetish and give it to the patient.[2]

One has heard of the burning of the paper on which formulas are written among the orientals and the drinking of the ashes mixed with water. The Pennsylvania Germans have a treatment for erysipelas by smoking yarns which have been measured over the patient. Erysipelas is called "cold fire" and is cured by passing fire around three times, saying each time, "Tame fire, take away wild fire."

Burns are also cured by blowing. The healer strokes the burn slowly three times with the right hand over it, bending down one, two, three times; and blow three times, each time three times.[3]

The Hakanyi or fire shamans of the Tewa Indians were members of the fire cult. Fire cures were practiced by them, and the custom was still in vogue among the Queres not very long ago. Bandelier has reconstructed their ceremony. In healing they sang their ritual song, waved flaming bunches of grass to the six regions, bit off pieces, chewed them, and spat in the patient's face.[4]

---

[99] Popular Science Monthly, August, 1884, p. 573.

[1] James Mooney. 7th Ann. Rept., Bur. Amer. Ethnol., 1885, p. 359.

[2] Information by Dr. Riley D. Moore.

[3] Emma G. White. Folk Medicine of the Pennsylvania Germans, Journ. Amer. Folk-Lore, vol. 10, January-March, 1897, p. 78.

[4] A. F. Bandelier. The Delight Makers, New York, 1916, pp. 40–41.

"A very strange remedy for fever, which I am told is still used, is to make a fire drill with a piece of hard and a piece of soft wood. The patient helps to work the drill. The fire passes out of his body and ignites the wood and he gets well."[5]

The United States National Museum has a healing torch from the Dyaks of Kwallan, Western Borneo. Dr. W. L. Abbott, who collected the torch, says:

" This thing is used to treat fever and other diseases. It is (said to be) made of 50 different kinds of wood, one stick from each kind. The powang or doctor sets fire to the large end and the patient inhales the smoke. In case of a child (as is most often) it is held over the burning fasces, which is placed on the ground." The torch has many kinds of wood, probably the required number. These are dressed into tapering rods and massed around the central rod of a holder, whose lower extremity is carved and fitted with a loop of cord for suspension; the rods are held in place by 9 bands braided from brown splints of some plant (pl. 33. fig. 1).

In regard to the use of fire products in superstitious healing, it is noted that the Hopi yaya or fire priests healed burns by their magic power and the application of soot. Layard observed the Yezidis venerating the soot from lamps for use in light ceremony.[6]

The Bushmen smoke ceremonially certain brushes of ostrich feathers which they make. They place the brushes in a funnellike hood of springbok skin and fumigate them with smoke from a certain root, the fumes passing through the hood. They control the fire so that it will not flame up.[7]

FIRE WALKING

The fire walk, in which celebrants pass over heated stones unharmed is a curious custom of the East described as an ordeal, though rather belonging to the class of fire juggling. Perhaps no form of ordeal is better known or more widely spread than this, its antiquity dating back to the days of Abraham and before, and being as various in form as it is ancient. The holy writ of various nations speak of it in no uncertain terms and the poet's fancy, tickled by what seems the conscious relenting of the pure element, laid hold of it in the last resort to redeem the honor of his heroes and heroines. Thus, when Abraham was cast into a fierce furnace by Nimrod for reproving the idolatry of the latter he escaped unhurt from the flames; and Zoroaster, when an infant, is related as having been seized by the magicians, who foresaw their future destruction at his hands, and thrown upon a huge burning pile composed of wood, naptha, and sulphur, but through the interposition of Hormuzd "the devouring flame became as water, in the midst of which slumbered the pearl of Zoroaster."[8]

---

[5] M. E. Durham. Some Montenegrin Manners and Customs, Journ. Anth. Inst. Great Britain and Ireland, 1900, p. 85.

[6] Henry Layard. Ninevah and Its Remains, New York, 1859, p. 184.

[7] Specimens of Bushman Folklore, pp. 359-361. Collected by W. H. I. Bleek and L. C. Lloyd, London, 1911.

Shadrach, Mesach, and Abednego are said to have met a similar experience when thrown into the fire by Nebuchadnezzar.[9]

"Of the sage Vasta, whom his younger half brother formerly attacked as the son of a servile woman, the fire which pervades the world burned not even a hair, by reason of his perfect veracity."[10]

Two hundred years before Christ, Eurius established himself as the leader of the insurgent slaves by breathing fire and smoke from his mouth, and Barchochebas, the ringleader of the revolted Jews in the reign of Hadrian, claimed to be the Messiah from his power of vomiting flames from his mouth. The priestess of Diana Parasya in Cappadocia, as Strabo states, commanded public veneration by walking over burning coals; and Shiavak, the gentlest and most amiable character in Shah-Nameh, proved in a similar manner, according Firdausi, his innocence when accused by his father, Kaoos, of adultery with one of his wives. Firdausi states that before doing so he applied camphor to his whole body and then passed rapidly through the fire unscathed. Voltaire suggests that the feat is no very extraordinary proof of skill or address when the movement is rapid and the face and hands are well rubbed with ointment. It was thus that the formidable Peter Aldobrandin, or the "fiery Peter," as he was called, managed when he passed between two blazing fires at Florence in order to demonstrate with God's help that his archbishop was a knave and a debauchee.[11] And in our own days we have read of a fireproof feat performed at Benares in broad daylight and in presence of creditable witnesses, not only by privileged persons but by any that willed it, fire being, according to them, previously brought under control.[12]

Mazdak, the Persian pseudoprophet and socialist, acquired great influence over the weak-minded King Kobad by his mystic fire, which was contrived to give answers, and Zoroaster was to a great extent indebted to his self-burning perpetual fire, which he always handled freely without feeling sensitive to its touch, for the rapid spread of his faith. According to Pliny the Hirpi family enjoyed the hereditary property of being incombustible, which they exhibited annually in the temple of Apollo on Mount Socrate.

Similarly Narpatarounal, or the festival of the fire, used to be held annually in India in honor of Dharmaraja and Draupadi, who had married five brothers at the same time, and every year quitted one in order to pass into the hands of another, but before doing which she always carefully purified herself in fire in proof of her virtue.

---

[8] Dabistan I?, p. 219.

[9] Daniel iii, 19—28.

[10] Manu VIII, p. 116.

[11] Voltaire. Philosophical Dictionary, Ordeal.

[12] See also the fiery ordeal of fire in the Wide World Magazine, vol. 1. No. 2.

In the Ramayana, when Rama, the incarnate Vishnu, distrusts the fidelity of his wife Sita, and bids her to betake herself out of his presence, saying, "Thou art to me like light to a diseased eye," Sita with tears in her eyes protests her purity before her husband, and finding him not convinced turns to Laxman, Rama's younger brother, and says, "Sumitra's son, prepare a funeral pile for me, the only refuge in this disgrace; publicly disowned as a wife, I can not bear to live"; and vindicates her honor by mounting a blazing pyre, from which she is rescued by Brahma, who comes to her assistance with a number of minor gods, and restores her with blessing to her dearly beloved Rama.

So frequently, however, was it used as the engine of torture and means of fraud that early as the days of the Jewish prophet Moses words of warning were sent forth denouncing its practice. The special mention of this in the Hebrew Scriptures is with regard to the passing of children through fire to Moloch, which was practiced for the purpose of purification and as a means of dedicating them to the service of the false god Moloch, an idol worshipped by the Ammonites, otherwise called Milcom.[13]

These atrocious practices of child sacrifices arose, no doubt, from the great readiness of remote antiquity to sacrifice even its dearest possessions to the service of God, whose favor it looked for, and its desire in return was a great wish to know that the sacrifice had been acceptable and the favor found. Imagination saw in the various phenomena of nature a meaning and an interpretation by which the Divine attempted to communicate with them, and fire, with its mystic nature and tongue of blue and yellow and swarthy rolling masses of smoke, was the fit means of conveying the early gift to heaven. This undoubtedly was the chief reason why fire came to be regarded as the most sacred element among some nations, as the Romans, the Parsees, and to a certain extent also the Hindus, and the fire sacrifices attained a superiority over all and developed most largely in some of the ancient religions of the world. To this feeling is to be attributed the practice of our Parsee brethren in burning sandalwood, frankincense, and other fragrant things on their sacred fire as a grateful and a sweet enjoyment for the gods, and a token that it had immediately mounted up to heaven and been accepted there.

The homa ceremonies among the Hindus derived their signficance from the same cause, and I believe the practices of burning corpses arose from a similar belief that the flames devoured and put the body face to face with his maker; and what better way could be found for the erstwhile wife and now the bereaved widow to accompany her lord and master by the selfsame direct route?

---

[13] I Kings xi, 7, and II Kings xxiii, 13.

Again, as fire could be kindled without human aid, as by lightning, catching the rays of the sun, or by rubbing two sticks or two stones together, it soon came to be recognized that the fire thus kindled was the best for sacrifice, as though God himself descended to meet and receive the offering.[14]

About 1900 the Polynesian fire walk attracted the attention of several scientific observers, and data on the subject were collected by Andrew Lang. No rational explanation being offered, the process remained a mystery. On the visit to the South Seas Dr. S. P. Langley, secretary of the Smithsonian Institution, had an opportunity to witness the most celebrated exhibitions of the fire walk at Tahiti conducted by Papa-Ita, a venerable hierophant of the ceremony: "In a pit about 9 by 21 feet and 2 feet deep cordwood was placed, and on this laid waterworn stones of porous basalt and fire set to the wood. The fire was continued for four hours, when attendants with long poles turned some of the stones over. Now the most impressive part of the ceremony began. Papa-Ita, tall, dignified, flower-crowned, and dressed with garlands of flowers, appeared with naked feet and with a large bush of 'ti' leaves in his hands, and after going partly around the fire each way, uttering what seemed to be commands to it, went back and, beating the stones nearest him three times with the ti leaves, advanced steadily, but with obviously hurried step, directly over the central ridge of the pile. Two disciples similarily dressed followed him, but they had not the courage to do so directly along the heated center. They followed about halfway between the center and the edge, where the stones were manifestly cooler since I had satisfied myself they could be touched lightly with the hand. Papa-Ita then turned and led the way back, this time with deliberate confidence, followed on his return by several new disciples, most of them not keeping exactly in the steps of the leader, but obviously seeking cooler places. A third and fourth time Papa-Ita crossed with a larger following, after which many Europeans present walked over the stones without reference to the priest's instructions. The natives were mostly in their bare feet. One wore stockings. No European attempted to walk in bare feet, except in one case, that of a boy, who, I was told, found the stones too hot and immediately stepped back."

Doctor Langley made an extemporaneous test by placing a hot stone in a bucket of water, and estimated that its mean temperature was 1,250° F., and also found that the material was a poor conductor of heat, so that it might be very hot beneath while above it might have been cool enough to walk upon without discomfort, especially with native soles unacquainted with shoes.

---

[14] The above notes are from the Journ. Anthrop. Soc. Bombay, vol. 6, 1902.

Doctor Langley concludes: "It was a sight well worth seeing. It was a most clever and interesting piece of savage magic, but from the evidence I have just given I am obliged to say (almost regretfully) that it was not a miracle."[15]

"During my four years' residence in Japan I had several opportunities of witnessing the spectacular religious or quasi-religious ceremony periodically observed at the Ontake Temple, Tokyo, in the course of which the officiating priests walk barefoot over a bed of live charcoal, throw boiling water over themselves, and climb a ladder of sharp swords set edge upward. All these pretended miracles, however, are susceptible of scientific explanation, and it is only with regard to the first mentioned, the fire walking, that I venture to ask the privilege of making a brief statement in Science.

"To the great mass of the spectators in the temple enclosure, who do not usually include more than the merest sprinkling of the more intelligent and better-educated classes of the Japanese people, the supposed miracles are the clearest demonstration of the supernatural power of the priests, who would have it believed that it is solely to their incantations that they owe their protection from injury. But it is not necessary to be a very close observer of their movements to perceive that the priests are not content with their perambulations, genuflexions, and prayers, but are careful to rub their bare feet with salt, ostensibly for purificatory purposes, before walking over the fire. This fact brought to my recollection the occasion, 40 years or more, when Tyndall astonished a distinguished audience at the Royal Institution by plunging his bare arm into molten metal, the then Prince of Wales, afterward King Edward VII, who was present, being prevented from following Tyndall's example only by the determined opposition of his wife.

"So sure did I feel of the efficacy of the salt as a protective agent that on my second visit to the temple I determined to follow the priests in their apparently hazardous adventure, and so after rubbing my feet well in the pile of salt I walked rapidly over the bed of glowing coal, some 18 feet long. My confidence was not misplaced. In my feet I felt only a sensation of gentle warmth, but my ankles, to which no salt was applied, were scorched.

"After a careful examination of such of Tyndall's works as I had access to at the Yokohama Club, without finding any reference to the demonstration at the Royal Institution, I wrote to Sir William Crookes, who not long before had mentioned to me his association with Tyndall in some of the experiments that preceded the delivery of the latter's famous 'Lectures on Light.' In due course I received Sir William's repy, in which after reference to certain matters of no special interest in this connection, he said:

---

[15] S. P. Langley. The Fire Walk Ceremony in Tahiti, Ann. Rept., Smith. Inst., 1901, p. 539.

" 'I do not know of any published account of Tyndall's putting his bare arm into molton metal, but I can well believe it, as I myself have plunged my hand into molten, almost red-hot, lead. I was in a profuse perspiration at the time, and immediately before I dipped my hand into strong ammonia to increase the spheroidal effect. I do not think the extra precaution was of much use, but I did not like to take a risk when looking at the cauldron of hot metal.'

"To physicists there is nothing new in all this, but not every scientific man is a physicist, or hypnotism would not have been suggested to me, as it has been, as the secret of the remarkable immunity I experienced."[16]

Dr. A. C. Haddon, observing the fire walk at Fiji, came to the same conclusion as Doctor Langley.[17]

Mr. Hyde probably has reference to the following incident, which is taken from the "Memoirs and Correspondence of Lyon Playfair," by Wemyss Reid, 1899, p. 201.

Playfair has told us in the preceding chapter of his reminiscences of the success with which he carried out this program for the instruction of the Prince of Wales in the practical application of science to industry. It was whilst the prince was living in Edinburgh as Playfair's pupil that an incident occurred which has already, I believe, been published. The prince and Playfair were standing near a cauldron containing lead which was boiling at white heat.

"Has your Royal Highness any faith in science?" said Playfair.

"Certainly," replied the prince.

Playfair then carefully washed the prince's hand with ammonia to get rid of any grease that might be on it.

"Will you now place your hand in this boiling metal and ladle out a portion of it?" he said to his distinguished pupil.

"Do you tell me to do this?" asked the prince.

"I do," replied Playfair. The prince instantly put his hand into the cauldron and ladled out some of the boiling lead without sustaining any injury. It is a well-known scientific fact that the human hand, if perfectly cleansed, may be placed uninjured in lead boiling at white heat, the moisture of the skin protecting it under these conditions from any injury. Should the lead be at a perceptibly lower temperature the effect would, of course, be very different. It requires, however, courage of no common order for a novice to try such an experiment, even at the bidding of a man so distinguished in science as was Playfair (p. 201).

At Raiatea Colonel Gudgeon, British Resident, walked barefoot over the fire oven with no ill effects.[18]

---

[16] John Hyde. Science, new ser., vol. 50 Aug. 15, 1919, p. 162.

[17] Nature, Dec. 11, 1902, p. 130.

[18] Journ. Polynesian Soc., Wellington, New Zealand, vol. 8, 1899, pp. 56–60.

A suggestion of the fire walk or of fire jugglery is contained in the narrative accompanying the Song of the Fire Charm of the Chippewa. The episode relates to the medicine rubbed on the feet, preventing injury when a man stood in the fire.[19]

PYROMANCY

Belief in the magic power and properties of fire appears in the many curious methods of applying this belief. Pyromancy, or the divination by fire may be treated here in connection with a number of more or less related customs, and a few of the many typical instances given.

Lafitau states that the Abenakis and the Algonkians are much addicted to pyromancy. They make charcoal of cedarwood, which they pound and reduce to an almost impalpable powder and which they spread out in a certain way, after which they touch fire to it and divine by the way in which the fire runs.[20]

This is a common and almost universal form of pyromancy, and sometimes unconsciously used by cultivated folk.

The Hutchin Kutchin Indians of Canada observed this superstition: "When the fire made a hissing noise they threw in some fat and asked to be able to kill some animal."[21]

The Maoris of New Zealand believe that a jet of gas from burning wood is caused by a soul that has come to obtain fire.[22]

It is seen that the various noises made by combustion of fuel in the fire are supposed to be voices of the fire spirit. Such beliefs of the folk are often embalmed in literature and serve to make senses of foreboding more terrifying and impressive.

George Brown says: "There is one supreme evil spirit who is called Sakusaku, and he is supposed to be specially active from sunset to midnight, after which hour he is not so dangerous. Fire is supposed to be a safeguard against him. Evil spirits are supposed to make a whistling sound, and if such a sound is heard at night the people in the house will cry out to poke up the fire and make it burn bright."[23]

Among many tribes fire is consulted before various undertakings the outcome of which is doubtful, as in war by the Mexicans and South African Bantu. This and many other customs are strongly held as a stage of culture when reverence for fire is deeply ingrained.

The Siberians use a form of pyromancy with flint and steel. Luck is determined by the way the sparks fly.

---

[19] Frances Densmore. Chippewa Music, Bull. 45. Bur. Amer. Ethnol., 1910, p. 103.

[20] Lafitau. Moeurs des Sauvages Americaines, vol. 1, Paris, 1724, p. 387.

[21] B. R. Ross. Ann. Rept., Smith. Inst., 1886, p. 325.

[22] Elsdon Best. Spiritual and Mental Conceptions of the Maori, Dom. Mus. Monog. 2, Wellington 1922, p. 11.

[23] George Brown. Melanesians and Polynesians: Their Life Histories Described and Compared, 1910, p. 210.

As a form of exorcism the Japanese had a custom of striking sparks from flint to the compass points to ward off evil influences. A Bushman exorcism to get rid of the evil influence of bad dreams is as follows:

"My mother used to do in this manner when she intended to go out to seek for food; when she was about to start she took a stone, and as she plunged the stone into the ashes of the fire she exclaimed 'Rider (?) yonder!' while she wishes that the evil things about which she had been dreaming should altogether remain in the fire instead of going out with her. For if she did not act in this manner, they would go out with her."[24]

A Finnish exorcistic vapor formula from the Loitsur (p. 136) is a curious example showing the extent to which the superstition may be carried:

"O Steam be kind, be moderate Heat,
Fall, Noxious Vapor, to the ground.
O Evil Vapor flee away
Out through the keyhole of the door
Or into the stones of the stove, inside
The moss that stops the crevices,
Or into the yard through a pipe, or through
The door, thou Vapor reeking of the bath."[25]

An example of exorcism by lamp flame from Merket, Turkistan, is given by Sven Hedin:

"The exorcisers enter the sick room and gaze attentively into the flame of the oil lamp, where they say they can see that the women is possessed of an evil spirit."[26]

Lafcadio Hearn says that in Japan fox possession is driven away by burning the patient.[27]

In the same country charms against fire consists of strips of white paper with text and picture of a black and a white fox.[28] Charcoal is also a protection against evil spirits.

Some curious Hindu superstitions from the central Provinces are given by M. R. Pedlow in the Indian Antiquary for February, 1900.

"To guard children against the evil eye their mothers disfigure them by applying lampblack to the eyes or make black spots on their forhead, cheek, or chin; but girls are usually tattooed, not marked in this way.

"When children are attacked by the evil eye they show it by their appetite falling off. To remedy this the mother takes salt, dried chillies, and charcoal, and puts them into a pot of water colored with lime and turmeric. This is waved three times over the child and then spilled on the ground, or the ingredients are cast dry into the fire with some of the child's hair."[29]

---

[24] Specimens of Bushman Folklore, Collected by W. H. I. Bleek, Ph. D., and L. C. Lloyd. London, 1911, p. 365.

[25] Hon. John Abercromby. The Magic Poetry of the Finns, Internat. Folk-Lore Cong. of World's Columbian Exposition, Chicago, 1898, p. 31.

[26] Sven Hedin. Through Asia, New York, 1899, vol. 1, p. 473.

[27] Lafcadio Hearn. Unfamiliar Japan, New York, 1894, p. 325.

[28] Idem, p. 152.

The value of fire in exorcism is believed by the East Africans: "On the other hand, a living man pursued by the 'bad people' was able to make good his escape by interposing a fire betwixt himself and the ghostly pack.[30]

This is like the story of the woman who drove the pig to market, and the obstacles were not overcome till "fire burn stick" supplied the impetus of power.

The Mohave Indians of Arizona have a dream superstition: "One may dream of being bitten by a rattlesnake, or one may dream that fire falls on his finger; in either case an actual rattlesnake will be the result."[31]

ILLUMINATION

Three great events have profoundly influenced the advancement of man. These are fire domestication, language, and agriculture. Without discussing the relative importance of these steps to civilization, it may be said that language is preponderantly a psychical development not entering the technological stage of writing until late, while fire and agriculture are technical from their inception. The phase of fire relating to light also came into importance long after fire had been employed in ceramics, metallurgy, and other key uses.

Fire adopted in the past became at once a source of light, which was artificial in the sense that it could be obtained at will at other times than when the fire was replenished. Light in the aspect of temorary expedients no doubt had had myriads of instances. The custom of the Kwakiutl Indians of British Columbia of throwing a dash of oil on the fire to produce a bright light is a case in point.) The brand taken from the fire suggests the torch, which is regarded as the beginning of illuminating devices. The classification of lighting devices is as follows:

Torch.—Vegetable, animal, and mineral. Torch holders.

Candle.—Vegetable, animal, and mineral. Candleholders.

Lamp.—Simple lamps to Argand and to modern lamps. Forms and improvements of lamp.

Gas.—History and development.

Electric.—History and development.

Modern inventions.—Magnesium, oxyhydrogen, acetylene, calcium, etc.

---

[29] Amer. Anthrop., vol. 2, new ser., 1900, p. 193.

[30] W. Scoresby Routledge and Katherine Routledge. With a Prehistoric People: The Aikuyu of British East Africa, London, 1910, pp. 74-77.

[31] A. L. Kroeber. The Mohave Indians, Amer. Anthrop., (new ser.), vol. 4, 1902, p. 280.

It is a question whether the first use of fire was not more for the benefits of its light than for any other quality. In a life the reverse of artificial, like that pursued by our remote ancestors, fire heat could only be a subordinate need. Anterior to all these considerations we must suppose that man liked fire and that he was heliotropic, as biologists apply the term. Thus it follows that his instincts were in accord with the act of taking up fire and making it a part of his material belongings.

The successive culminations of lighting inventions is graphically shown in the following illustration (fig. 3).

The rational of light is still subject to investigation, in which progress is being recorded, but nothing conclusive as to its physical explanation has yet been reached. The natural cause, which is the first division, and the manifestations of light in nature are not in the scope of this work. Artificial causes in the sense of man's manipulation of this branch of the correlated forces of nature to minister to his needs is the second division. In this branch is seen the development of illumination from simple devices to complex adaptations drawn from chemistry and physics. Thus the history of illumination may begin with the burning brand, cover the wide field of illuminants, becoming more complex through reactions of other activities, until it reaches the threshold of the age of science and invention. It is observed that illumination throughout the greater part of its history depended upon organic materials, that is, carbon fixed by life forms. In the age of science and invention, which may also be characterized as the age of the harnessing of the physical forces, electricity opens a new field and a new illuminating agency.

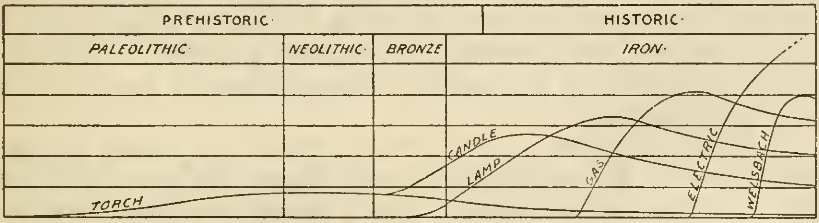


FIG. 3.—GRAPH ILLUSTRATING THE RISE AND CULMINATION OF LIGHTING INVENTIONS

The purpose for which light is to be used, the place of its use, the culture period, and the environment are modifying influences on materials and the character of the apparatus.

It appears inevitable that the higher types of illumination apparatus would not have arisen save in the temperate zone, where the nights are long. The open fat lamp would seem to originate in many cases from the kind of fuel available for burning, as well as from the enforced simplicity of a low stage of culture. The Eskimo were compelled by their environment and the character of the fuel to use an open lamp.

The various interactions of environment, fuel, etc., as in the case cited, often give rise to forms of extreme primitiveness in the midst of inventions which evidence a high civilization. As a historical fact the tropical and subtropical lamps were simple and undifferentiated because there was very little need for artificial light, since the uniform day and starlit night, together with the simple habits of the people, rendered better means unnecessary and accordingly not liable to appear under these repressive influences.

The broad periods of day and night with shadings of twilight form the natural optic environment in which man is planted as a part of animate life. The natural state of existence which is assigned to early man enforced upon him a general uniformity. The activities of vegetation are for the most part diurnal; of animal life diversified, that is, relegated to night and day according to specific habits. Man being in growth uniform with the animal kingdom, was in his activities primarily a day animal, providing for himself a place for rest at night and not roving abroad for nocturnal adventure. The normal life of tribes in a low state of progress seems to bear out the latter generalization.

The change in habits brought about in the human species through the adoption of fire and thence in some degree the use of artificial light has a speculative interest. That a change took place, however rudimentary at the outset, is undoubted. It is easily imagined, even logically to be advanced, that the earliest appreciation of fire was psychological, its brilliancy at night in contrast with its eclipse during daylight being most marked and giving a sense of comfort and reliance. In no sense were the utilities of fire comprehended. It is possible that the ancestors first took up fire as they would a bright stone, feather, or anything else that might excite the curiosity.

Naturally, there was other experiences connected with the capture of fire that are not necessary to be discussed here.

The utilities that followed the possession of fire, however, are within the province of safe speculation. Of these uses the first is light, which thenceforward from the small beginnings would produce increasingly changes in the habits of man. The consideration of light as a civilizing agent of importance would touch upon the advances in the science of illumination, using the steps as an index of man's progress in culture. We may now in this age sum up the benefits that light has conferred upon civilization and may prophesy concerning the developments with which the future is burdened.

Before sketching the salient features of the subject it may be mentioned that the attractiveness of light for many species of animals is a matter of common observation, and it is also known that many species possess light organs as part of their economy. Hence the lures of hunters and fishers, and the sexual and other lures of light-producing animals. It has perhaps been less noticed that the habits of animals are much modified by the artificial lights of man, especially under the relatively great increase of gas and electric illumination. Night-flying insects generally have suffered, because their reaction to light is total. Day-flying insects have taken on an extended term of activity, as may be observed in the change in the habits of the house fly. The tragedies which surround an open arc lamp are familiar to city dwellers. and among the myriads of dead or stunned insects, bats, and toads ply their quest by the aid of artificial light. The lights along trolley lines and country roads also must be responsible for great dislocations in the habits of animals. Migratory birds have suffered losses from lighthouses, not being, as commonly said, bewildered by the glare, but more probably yielding to the attraction of light.

Observations seem to render it possible to classify animals by their reactions to artificial light into animals averse to light, those neutral or favorable to light, and those more or less strongly attracted by light. There would be considerable discussion for and against as to natural reactions to light of the different races of mankind if such a statement were brought forward that tropical man dislikes light, Temperate Zone man is neutral to light, and Frigid Zone man likes light. In reality the preponderant factor here is the preservational instinct by which man adjusts himself to his surroundings. A profound need, however, is expressed by the fact that artificial light is one of the more prominent inventions which man has brought to his aid and at which he has assiduously worked. The use of artificial light has become a human characteristic. Some observations on the zonal environments connected with the development of artificial illumination and its chief features are sketched below.

In civilization, where social differentiation had developed the active, cultured, enterprising, intellectual, ecclesiastic, and parasitic classes, the need for more light was first felt. The weary masses remained practically in a primitive state with regard to the common uses of light, and the bulk of humanity still remains so. This vast substratum forms the material upon which the illumination engineer works, and the economic possibilities here are apparent.

THE TROPICS

The equality of duration of day and night in the Tropics tends to conservatism in the arts of life. It will be seen that in the Tropics inventions for the production of artificial illuminaton are most primitive. The Tropics are overwhelmingly in the torch and candle stage, and show only a rudimentary beginning of the lamp in some of the higher tropical and subtropical civilizations. Since inventions reflect human needs, the demand for lighting apparatus was at a minimum in the Tropics and it is evident that work connected with arts and industries were preponderantly carried on in daylight. The work periods varied somewhat for different occupations, but generally were massed on the fringes of the day before the sun had reached his full power and when his rays begin to lose their burning effect. It is evident, however, that the basic inventions which underly the present science of artificial illumination were worked out by endless more or less unconscious experiments by the inhabitants of this zone.

THE TEMPERATE ZONE

Radically different conditions obtain in the Temperate Zone, with its seasonal variations of the intensity and duration of light and the climatic and economic stresses characteristic of the enviroment of the most enlightened section of mankind. This zone furnishes the greatest variety or variability of enviroment. It is the zone of incentive. The arts of the Tropics transferred to the Temperate Zone have reached their greatest development. Man and his arts have reacted and interacted here to their fullest extent, and the result instead of being climactic mark only the beginning.

Of these developments the effects of illumination upon social life and the ensuing reaction upon the inventions of devices to produce better illumination reflect only one of many striking achievements of progress. Nevertheless, the science of illumination, as we know it, is very recent. The chief difference between the Tropical and Temperate Zones in respect to illuminating apparatus of the noninventive peroid is in the adaptation of such apparatus to the needs prescribed by the enviroment.

THE FRIGID ZONE

The Eskimo, according to travelers, spend the long winter's night in preparing their hunting equipment for the ensuing summer, fashioning ivory, skin, and stone into objects of use, and they consume much time outside of such economic pursuits in carving trinkets for the children, masks, and other objects which display great inventiveness.

The life of the Eskimo during the winter is not the struggle with ennui which the civilized man fights when camped in the Arctic, limited in action by the cold and the darkness, and hemmed in on himself by such depressing conditions that he must find occupation or die. The native, on the contrary, has ever before him a vast outstreching need for tools of the best quality for taking the animals which he not only requires to supply his food, but the materials for clothing, transportation, and even the implements by which the animals themselves are captured. He is at the zero of vegetal food in his subsistence and at the top of the scale in the use of animal resources in his culture. Again, he is at zero in the amount of daylight at the period when house occupations are necessary. His need for artificial light is imperative. It will be seen then that nothern latitudes conduce to progress on account of long nights and long periods which can be devoted to work within the house. Nature in the desert and favored lands stimulates contemplation in open air. Northern unfavored lands drive men to hard toil and give little time for contemplation. Here the enforced house life, with its occupations and associations, strengthens the mind and enlarges the brain. The theory is that to house life more than mastery of land or sea is due the advancement of the Scandinavians. This theory, which partakes of the uncertainty which surrounds conclusions, had much in its favor. It is supported by the observation that the Eskimo are the most inventive of the races of man, but is open to question as to cause by reason of the fact that tribes in a similar rigorous environment are quite backward.

The social nature of mankind, demanding the gathering together at times of groups for various purposes, originated many features of interest which have been observed in the life of tribes nearest to or whose condition is suggestive of the primitive state. Survivals also of primitive customs give valuable data in this connection. The activities referred to appear mainly in the night side of man's life, when the distractions of diurnal work are laid aside, and consist of ceremonies in which dramatic elements preponderate. The chief requirement of these "dances" is a fire, or sometimes they are performed under the natural light of the moon. In these ceremonies among all races of man the fire is the nucleus of the night observances. There must be considered here the psychology of man's behavior toward fire, with the concomitant stimulation to the emotions excited by this element. These emotions are not stimulated by sunlight, and to a limited extent by fire in the daytime. The motion rhythm of fire seen at night may partly explain this, and instinctive survivals brought up from the subconciousness play a strong part. Bonfires produce an exaltation mingled with a primitive terror arising from a knowledge of the effects of unrestrainable conflagration, the might of fire when it gets loose. It is instinctive when a bonfire is well under way to look around and reassure oneself that it can not spread to other combustible materials. Animal behavior with regard to fire and its bearing on human reactions forms a chapter of psychological investigation which can not be entered on here.

There is one curious phase of the effect of artificial light upon the communication of ideas to which attention is called. Wherever gestures are a component of language and more or less essential to expression and to understanding on the part of the auditor, visuality of the speaker would be of advantage. Consequently artificial light may be essential to communications at night. It is of frequent observation that light is used and required by aborigines in circumstances where legends and stories are told after nightfall. The value of noting the facial expression of the speaker is also important. Following this by-product of the subject it may be inquired whether there is a basis for the observation that the speech of various groups of men is fully gesture-aided, incompletely aided, or destitute of such aid. Gestures may be considered as the communication of ideas by means of muscle reading or as symbolic or pictorial, suggesting the incorporation or survival of sign language as an element of spoken language.

The impression is that artificial light is an important factor in aiding the expression of ideas through speech.

It is interesting to note that architecture and light are so closely connected in cause and effect. The house is usually thought of as a protection against cold, heat, rain, or wind, but rarely as a protection against light. Nevertheless this feature is as prominent as any mentioned, due weight being given to the environment. The racial characters of house construction are not considered here, but it will be found that the simple dwellings of uncivilized races have covered the light problem as well as the complicated houses of the civilized. It may be remarked that the window opening and roofs of the houses of civilized man are the chief features by which artistic expression of buildings is achieved.

Many domestic industries were carried on by firelight, and the family gathered about the hearth has always formed a picture which can not be excelled in primitiveness. Needs, however, for a rather special concentration and position of the source of illumination stimulated the invention of holders, brackets, stands, etc., about the fireplace, using primitive wood illuminants whose combustion produced a reek of smoke, requiring a long experience to produce a partial immunity. For moving the light about more freely then came the torch stand, the candleholder, or some form of grease lamp. Gradually occupations which required careful seeing developed forms of lighting apparatus suited to their special needs, as the weaver's lamp which could be hung over the work, the brewer's lamp, which could be stuck in a post or barrel, and the like. Often the kitchen preserved the most primitive styles of illumination, while the "best room" had the latest. There arose, therefore, in the early period a considerable diversity in illuminating apparatus designed for special needs without in any way leading to the production of better light. The effect, however, of the increased utilization of light through increasing the hours of labor is notable and has produced a great effect upon human progress.

All products of man's inventive thought are subjected to a constant improvement. When man felt a need for artificial light and devised the first way of making it shine forth for his use, from that moment the electric light was a foregone conclusion. More light was the keynote, and with this in view the history which is unfolded in the struggles for improvements in lighting makes up one of the most instructive chapters of progress.

The division of the day into the ideal periods of work, recreation, and sleep has been sadly disorganized. The period from Argand to the present has seen inventions for increased illumination so radical that the human mind tires of the effort at comprehension.

The growth of the use of artificial illumination increases *pari passu* with the expansion of human culture, and is an instance of the correlation of supply and demand. The variety of uses to which illumination is put also greatly increases in response to social and industrial developments, but from the point of view of invention looking to better light there may be negligible progress. This is the history of artificial illumination from the beginning of the definite use of the lamp through the rise and fall of great civilizations to less than two and a quarter centuries ago. A tremendously long period also elapsed between the primitive illumination usages and the employment of the simple vessel called the lamp.

All inventions have as a basis the need for surmounting or rendering subservient natural obstacles. Upon these inventions are pyramided improvements, other lines of inventions and interactions, combinations, and developments in bewildering array. It is to be expected, therfore, that man would carry forward his use of fire to the field of illumination, and this would occur at an early period.

REMARKS ON THE FUTURE OF ARTIFICIAL LIGHTING

The present age looks forward to procuring an abundant and cheap source of brilliant light obtained also with a minimum of mechanical aid. It is admitted that this is an ideal worth striving for, difficult of accomplishment, but not an impossibility. As part of the work of the world it has received unremitting attention since the beginning of human consciousness, growing slowly for a long period and more and more rapidly to the present. In the little span from 1780 to now a vast comprehension of the world of radiant energy in its application to the science of illimination has taken place. We may look with allowable confidence on the near attainment of the desiderata mentioned above.

The inevitable tendency of the lighting arts is to build up enormous systems of producing and distributing, the complexity of this group of industries becoming rapidly greater with every advance in the two phases mentioned.

Ancient man wrenched some bark from a tree, made it into a bundle, lighted it at the camp fire, and the whole industry was covered. Modern man mines coal, transports it, burns it, steams engines, runs dynamos, gets electricity, regulates it, distributes it, measures it, and leads it into the lamp, using scores of direct or collateral industries and hundreds of inventions in the process. A catalogue of the requirements of this gigantic congeries of industries, whose ramifications appear to be unlimited, would require the continued effort of many individuals. For ages man merely set the train by which oxygen would combine with carbon at a rate which produced the phenomena of heat whose useful end term was light. For an enormous span in man's history lighting remained as an art untouched by science, and utilizing only the obvious promptings of nature to the effect that light was one of the results of the combustion of organic and some mineral substances. The group consisting of natural or easiest available minerals used for lighting are carbon minerals, which without refining are of little value except in the case of natural gas. The solids of this class were found suitable for the crude methods of outdoor lighting practiced in early times, and the semisolid and fluid members found a limited use in later times, being frequently mentioned by classical writers.

The other group consists of organic substances, such as wood, resins, waxes, fats, greases, and oils, which from ancient times were the chief reliance for light. These substances possessed a higher degree of combustibility and gave less residue of a disagreeable character than substances of the first class. It is evident from experience that a fuel fulfilling the exacting conditions required for lighting can not be derived from this class. It is also true that until the advance in chemistry reached a high point the first class of substances could not contribute as they have done to the science of illumination and in other ways to the welfare of the world.

A third class marking an important step in advance is remarked in gas, at first collected in a pure state from the laboratory of nature, and later the product of chemical engineering. Natural gas was known to the ancients, but they had no facilities for its practical utilization, and to the Chinese, whose possession of bamboo tubes gave rise to some efforts in conducting and use. Coal gas was also observed to be a by-product of the combustion of soft coal by the earliest users of this fuel. In metal working practiced from quite ancient times the smelters must have observed the accumulation of gases. Nevertheless, by the inexorable law of progress the technical requirements and public needs did not synchronize till the close of the eighteenth century. Still another class of comparatively recent discovery is radium and the radioactive elements. In the research for light these elements have not as yet shown any promise. To use the worn expression, "if we had a considerable amount of radium" something would come of it in the way of illumination, but not heatless light.

It is not necessary that the light of the future should be without heat, however much this feature might be desired. The requirement appears to be the harnessing of a force now just out of our reach, but which science sometimes feels is close in, which intensive work and good fortune will put under our control. This desire to reach for the key to the stronghold of illimitable force may be irrational, the possession of the secret might lead to a world-enveloping catastrophe, but when did science show fear in entering the arena of the unknown?

A fourth class, that of electricity, did not emerge in any encouraging degree till the latter part of the nineteenth century, when mechanical technology began to furnish means for achievement of electric lighting. Beginning with the arc, that wonderful discontinuity, there followed a bewildering series of inventions and improvements which have given us our most modern light. The limits of electric lighting, we may say with caution, appear to have been visioned. It is probable that from this branch the lighting of the future will not be derived. Up to this period all artificial light utilized was yielded by the incandescence of particles of carbon in a gaseous medium of high temperature. The early electric lights were also of this class. There is about to be developed here illumination not depending on this age-old feature.

There is another class of substances of comparatively recent isolation which give promise as to the light of the future. As a result of extended experiments thorium oxide containing a trace of cerium was made to produce the powerful radiations familiar in the Nernst and mantle lamps, economically also in the latter by using the less-expensive fuels as gas and coal oil, especially the latter. Certain other chemical elements, such as calcium, magnesium, phosphorus, tungsten, uranium, vanadium, etc., possess possibilities which have not been fully explored.

The present state of our knowledge of the nature of light represents a very marked advance. The chief feature which seems to be established is that light has mass. That it has the utmost conceivable velocity possessed by matter in motion is not a novel statement. Professor Langley's calculations that one thirty-quintillionth of a horsepower is capable of making us see sets a term to the natural vision. It was also pointed out by Professor Langley that light as produced by man is the result of a wasteful expenditure of power from a human standpoint. This waste of energy is caused by the necessity of bringing the emitting substance from normal to incandescence. Celestial light is seen to be the result of a prodigal expenditure of the illimitable forces of nature.

In the organic world, however, we find a remarkable phenomenon which seems to set at defiance our previous observations and painfully built mechanical structures, a light produced without heat, exemplified in the common firefly. Dr. E. Newton Harvey [32] states that progress in the realization of heatless light will not be made until the synthesis of the light-emitting proteins is accomplished Since proteins are among the most complex of organic substances, no protein having as yet been synthesized, we are here in the presence of one of the many mysteries of organic reactions in the handling of which chemists and physicists have only made the faintest beginnings, have in fact only advanced by grace of fortunate guesses or accidents, as Dr. D. C. Gilman has pointed out in his remarks on organic synthesis. In these cases what seems to be simplicity itself is too often only enormous complexity. It is believed that the attainment of heatless light would be of great importance to the world, but it seems inevitable that mankind must wait patiently for a long time for the result. Doctor Harvey also says that the light if acquired would be too green for comfort, in fact as distressing as the mercury arc light.

The cumulative results of science and the amazing interactions of these results, their elucidation of problems in other fields, their new points of departure for other investigations in totally unexpected lines, can not but hearten those who survey the field as to the potentialities of the future. The wonders of nature transcend the wonders of science, but no one may dogmatize and set limits to man's cunning. It is, therefore, not improbable that heatless light may be realized, though we may not predict that it will come through the organic world.

It is affirmed by physicists that all substances send off radiations, therefore if the human eye was an all-efficient organ man could see by a multitude of lights. Beyond the limited range of the eye, however, man is compelled by instrumentalities devised by himself to explore what in our circumscribed perceptions we call the dark places. Our first insight into this vast region was conferred by that epoch-making instrument, the spectroscope. The components of light made known by the spectroscope showed clearly that this common radiation is extraordinarily complex and that it bears the stigmata of all existing things carried from the ends of the universe. Spectrum analysis with constantly improving instrumentation has made great strides not only in telling us of the materials of the universe, their conditions and motions, but also of forces carried in light, the nature and purport of which we are still in ignorance. Spectrum analysis is still in its infancy; the groundwork is done, but each step in advance now requires a great outlay in patience and money.

---

[32] The Nature of Animal Light. Philadelphia, 1920.

The utilization of artificial light viewed so far as may be possible in its entirety is a record of achievement in which the sensation of wonder finds itself overworked. George Iles, in his Flame, Electricity, and the Camera, makes illuminating excursions in this field of marvels and touches the salient features. It is a trite saying, however, that no one can keep abreast with the advances in a single one of the specialties of science.

Inquiries into the nature of light have furnished materials for a classification of the kinds of light. It is now known that there are a number of kinds and qualities of light. The light with which the common human activities are concerned is that form of "radiant energy" to which the human eye in its development has adapted itself, or, to turn it about, has caused the eye to be forced to its appreciation. This is sunlight, the standard by which all the varieties of light observed by us are rated. The illumination engineer in the endeavor to furnish light in the greatest amount and of most general use seeks to approximate this white light. He strives to turn night into day.

The analysis of white light by the spectroscope immediately renders it evident that the eye is concerned with only the short range of median colors to which it is adapted, the red, yellow, and orange. The eye perceives all the spectrum the character of whose energies is capable of inciting the function of vision.

The human eye has developed in two lines, namely, 1, accomodation to daylight by structural developments to regulate the amount of light falling on the sensitive surface, and 2, accommodation to diffused light by which the sensitive surface registers to the minimum of radiation. Man's eyes register to light only, and he is therefore required to move about in the dark mainly by means of a tactical sense combining other senses. That "seeing in the dark" is possible is a widespread but false belief.

The chronicle of fire, with its body of wonderful achievements in the development of arts for the benefit of mankind, is nearing the end. Other forces more wonderful are on the point of being unlocked, and they will cause the crude thaumaturgy of fire to appear as ridiculous as the incantation of a medicine man.

FIREFLIES

Of the natural sources of illumination the most suggestive and perhaps forward-looking in the trend of modern science is the use of fireflies for light. As a method of illumination firefly light stands alone. It can not be assigned as a step in the origin of the torch or lamp. It can only be placed with a series of crude efforts which show the mind of man at work on a specific problem which has confronted him, eventually to crystallize in a torch, a lamp, or a candle.

There are numbers of instances in America and the Far East of the use of light-emitting beetles, in the former region a *Pyrophorus* and in the latter a *Lampyris*, names of the type genera. The *Pyrophorus* is an insect 1 to 1¾ inches long, having two circular light areas on the sides of the thorax and a large flashing light area on the abdomen. The *Lampyris* produces light flashes from the abdomen alone, as is the habit of the familiar Temperate Zone species in America.

Early historians of tropical America were struck by the novelty of the *Pyrophorus*. Herrera in his account of Hispanola says:

"There were at first found a sort of vermin, like great beetles, somewhat smaller than sparrows, having two stars close by their eyes and two more under their wings, which gave so great a light that by it they could spin, weave, write, and paint; and the Spaniards went by night to hunt the Utias, or little rabbits of that country, and a fishing, carrying those animals tied to their great toes or thumbs, and they call them *Cocuyos*, being also of use to save them from gnats, which are there very troublesome. They took them in the night with firebrands, because they made to the light and came when called by their name, and they are so unwieldly that when they fall they can not rise again; and the men stroaking their faces and hands with a sort of moisture that is in those stars, seemed to be afire as long as it lasted.[33]

Bernal Diaz in his first experience with the *Pyrophorus* thought them to be the matchlocks of numerous enemies in the forests and ordered his soldiers to prepare for action.

In a tapir hunt on the Mosquito Coast Squier describes his attendant as catching his hat full of fireflies, which served to guide them in the bush. He then pulled off their wings and scattered them through the fallen trees, where they gave light enough to enable the hunters to distinguish objects with considerable clearness. [34]

In 1858 Charles Lazto sent to the Smithsonian a Pyrophore with the following description:

"From Chinameca, on the Isthmus of Tehuantepec. When the bug is alive the two round spots on its back give such a powerful and steady light that in a dark room all objects can be distinguished, and at a distance of 6 inches small print can be read. At lamplight their light is of beautiful bluish-white color without flickering. Owing to this they are caught in large numbers, and the women going into the fandango (national dance) which they have twice a week, namely, on Saturday and Sunday nights, all through the year, fasten them on their hair and headdress, and sometimes they make whole garlands on their dresses of these poor shining captives, when, as they are dressed very gayly and full of jewelry, one would would mistake them for fairies."

---

[33] Herrera. General History of America, London, 1725, vol. 1, p. 277.

[34] Mosquito Coast, London, 1856, p. 137.

Another traveler records:

"The Pyrophores are insects about 1 inch long, from Mexico, where they are found in the forests. They are very brilliant and it is said that the Indians of Mexico use them for light at night, as a few are enough to light a whole room. When they are walking at night they put one on each foot, so that they can be sure of their way and to avoid snakes. The Mexican ladies buy them of the Indians and enclose them in a transparent bag, which they wear in their hair or at the neck. The effect is very beautiful, especially when several are worn; and as the Indians sell them for a few cents a dozen, they are within the reach of every señorita. They are fed on sugar cane, and if well taken care of will live a long time. One placed on a page will enable it to be read with ease on the darkest night."[35]

The celebrated naturalist Kaempfer in 1690 said of the fireflies of Siam: "Sitting upon the trees, like a firey cloud, the whole swarm would spread themselves over its branches, sometimes hiding their light all at once, and a moment after shining forth again with the utmost regularity and exactness, as is they were in a perpetual systole and diastole."[36]

Lafcacio Hearn tells a story of a Chinese student who inclosed fireflies in a paper lantern and was thus enabled to obtain light to study after dark.[37]

In Japan fireflies are an adjunct to all grades of social festivity, from the private garden parties of nobles to an evening at a cheap tea garden. Sometimes they are kept caged, sometimes released in swarms in the presence of guests. To supply this demand there are a number of firms in Japan employing men to catch the fireflies.

At sunset the firefly hunter starts forth with a long bamboo pole and a bag of mosquito netting. On reaching a suitable growth of willows near water he makes ready his net and strikes the branches twinkling with the insects with his pole. This jars them to the ground, where they are easily gathered up.

But this must be done very rapidly, before they recover themselves enough to fly. So the skilled catcher, sparing no time to put them at once into the bag, uses both hands to pick them up and tosses them lightly into his apron, where he holds them unharmed till he can hold no more, and only then does he transfer them to the bag.

---

[35] Pop. Sci. News, November, 1885, p. 154.

[36] Aug. St. John. Lives of Celebrated Travellers, vol. 1, p. 289.

[37] Glimpses of Unfamiliar Japan, vol. 2, New York, 1894, p. 459.

His work lasts till about 2 o'clock in the morning, when the insects leave the trees for the dewy soil. He then changes his method. He brushes the surface of the ground with a light broom to startle the insects into light; then he gathers them as before. An expert has been known to gather 3,000 in one night.

Besides being a business, firefly catching is a sport in Japan. Little girls pursue the insects with their fans, boys with wands to which a wisp of yarn is fastened, and they sing and old folk rhyme as they follow the glistening insects. Nor do their elders disdain to join the sport. They organize festival parties to visit certain spots long known and famous to witness the beautiful spectacle of the fireflys swarming.[38]

Necessarily in the employment of fireflies as light for various purposes there would arise the need of apparatus for confining the insects. In the West Indies this has taken the form of a lantern with a grating of small rods, like the cages in which the Chinese keep fighting crickets (pl. 32, fig. 1). Another form closer to nature is the calabash perforated with many small holes and furnished with a door. Humboldt describes the latter form used under remarkable circumstances during a voyage from Cumana.[39]

Miss E. R. Scidmore brought to the United States National Museum from Java a curious firefly lamp consisting of a small oval wooded box with pivoted lid. The interior is lined with pitch, upon which fireflies are stuck. Reserve fireflies are kept in a cane tube. The apparatus is described as a burglar's dark lantern (pl. 32, fig. 2.)

The exact scientific experiments with the light of the firefly carried on by S. P. Langley and F. W. Very in 1890, and many others at earlier and later periods, have given scientific data on the photometric and thermal properties of the light and the vital processes concerned in its production. It was thought that these experiments might be an introduction to the utilization of this heatless light and that a revolution in illumination might follow. There was, however, only uncovered a problem of undreamed-of complexity, whose solution awaits an indeterminate future.[40]

TORCH AND CANDLE

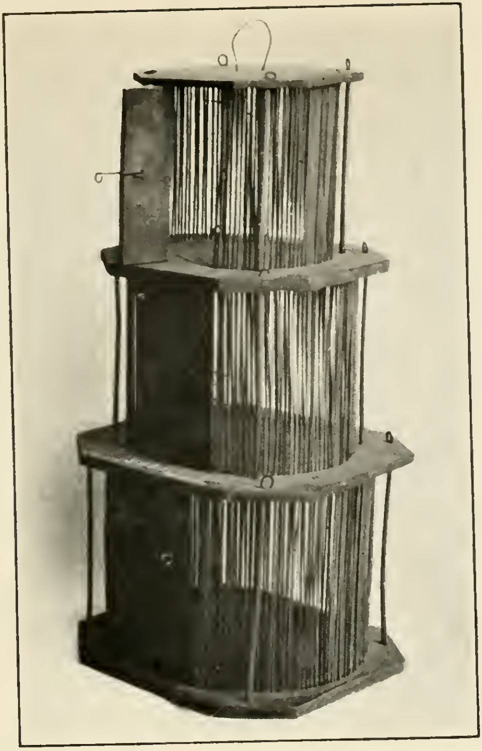
There was a stage in history of illumination in which the torch was almost the sole artificial light. The torch stage also comes close up to and overlaps the inventive period, but is fast passing away before modern appliances. A review shows that almost all tribes

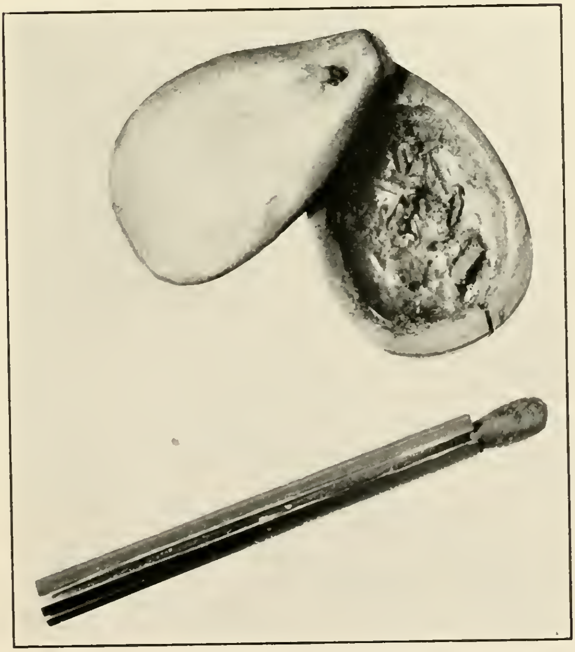
---

[38] Article in the Washington Herald, Aug. 24, 1910, from Harper's Weekly. See also Scientific American Supplement, No. 1138, Oct. 23, 1897.

[39] Travels and Researches of A. von Humboldt, Edinburgh, 1832, p. 262.

[40] F. Alex. McDermott. Recent Advances In and Knowledge of Light by Living Organisms, Smith. Rept., 1911, pp. 345–362. This paper gives an extended bibliography of the subject.

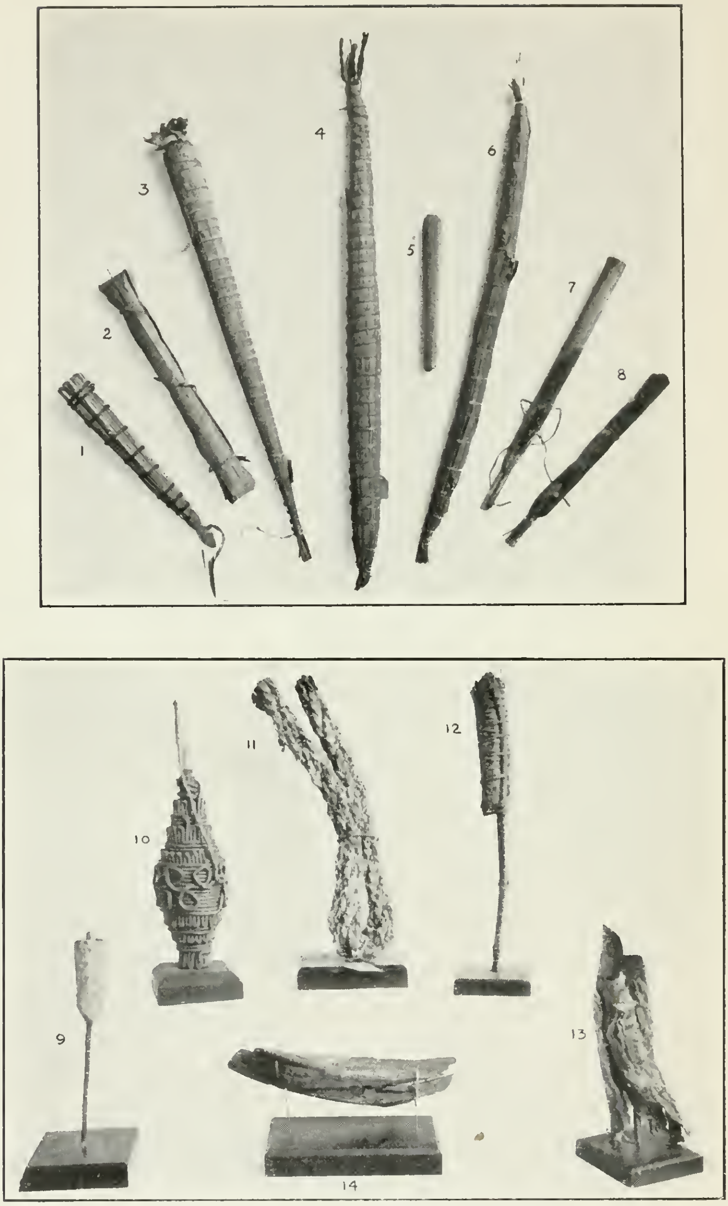




FIREFLY LANTERNS

Top, West Indies; bottom, Java

FOR DESCRIPTION OF PLATE SEE PAGE 198



TYPES OF TORCHES. TORCHES OF RESIN

1, Borneo healing torch; 2, Karens, Burma; 3, Lower Siam; 4, Mindanao, Philippine Islands; 5, Porto Rico, West Indies; 6, Gaboon, Africa; 7, Lower Siam; 8, Singapore; 9, Mass of fat on a stick, Mongolia; 10, Fancifully wound taper, Virginia; 11, Link, Spain; 12, Mass of resin on stick, West Africa; 13, Candle-tree bark for torch, Mexico; 14, Fat pine torch material, Virginia

FOR DESCRIPTION OF PLATE SEE PAGES 199 AND 202

in the Western Hemisphere were in the torch stage. The Old World, except in the areas where great advance in civilization is seen, is also in the torch stage.

There is presented here a series illustrating and suggesting the development of the torch and candle. In this series the torch merges into the candle in accordance with the relationship which exists between these forms of illumination. It is understood that the series only gives the stages of advance in invention and does not give genetic relationships (pl. 33).

1. Tropical fireflies in a perforated vessel, for giving light. West Indies.
2. Stormy petrel, burned in the Orkney Islands for light.
3. Candlefish in a split stick, burned for light. Alaska.
4. Torch made of birch bark. Iroquois Indians.
5. Torch made of split fat-pine knots. Virginia.
6. Torch made of cut strips of coconut bark tied into a bundle. Malays.
7. Bundle of resin enclosed in palm leaf (outside wick). Malays and Congo tribes.
8. Torch made by soaking rope in resin. Europe in the Middle Ages.
9. Torch composed of cords soaked in fat or wax. Europe, sixteenth century.
10. Cord soaked in fat or wax, coiled for lighting. England.
11. Rush soaked in grease, forming a primitive candle. England.
12. Stick smeared with grease for lighting. Mongolia.
13. Mass of fat formed upon a stick, around which is wound a wick of fiber. Kashmir, India.
14. Candles formed of wax; wick of fiber. Japan and North Africa.
15. Dipped candles; wick of cotton. United States.
16. Molded candles. Patent candles of stearine, paraffin and wax, and decorated candles. Nineteenth century.

ANCIENT

The most ancient torch known is from the old Stone Age in France, about 100,000 years ago. M. de Mortillet says: "The excavations of Vareze have produced inflammable branches bearing traces of charring near the end which has taken fire. These are the most ancient torches known."[41]

In ancient Greece the torch, *dais*, was a piece of resinous wood.[42] An archaic votive tablet from Argos, Greece, represents Artemis with a torch in the right hand and a bow in the left.[43]

---

[41] Bull Soc. de Anth. de Paris, vol. 25, 1870, p. 143.

[42] Henry Schliemann. Troja, New York, 1884, p. 146.

[43] Cast in U. S. National Museum.

Strabo remarks that torches, pitch, resin, and wax, among other things, were supplied by the mountaineers of the Alps to the plains peoples.[44] Strabo also quotes Pindar, in his Dithyrambus: "For thee, O Mother, the large circles of the cymbals, and the ringing crotala; for thee blaze the torches of the yellow pine." [45] Pindar referred in this quotation to the Curetes or Rhea (or origin) rites of ancient Greece, in which primitiveness was studied. The actors dressed in archaic style, and among other games races were run by men bearing torches, and the musical instruments were of the most ancient kind.

The torch was used in many ancient feasts and ceremonies, not as a form of illumination, but as a symbol. The torch is a well-defined symbol current to this day. It is conceived as not only a bearer of light but as a carrier of fire of destruction, thus connoting the firebrand and light producer.

NORTH AMERICA

In North America the torch takes on environmental phrases, as in other parts of the world. It will also be found to vary from quite simple to elaborated forms in accordance with the culture status of the tribes.

The Eskimo are said to have used a variant of the torch, consisting of a bone dipped in fat. The Eskimo of Jakobshavn, Greenland, used a similar torch described as a bit of wood charred at one end where it has been dipped in oil and burnt for temporary light. (Specimen in the U. S. National Museum, collected by P. Sorensen.) Along the northwest coast of America north of the Columbia River immense shoals of the eulachon or candlefish occur, running up the river to spawn as the salmon. The eulachon is a deep-sea salmonoid fish, *Thaleichthys pacificus*, resembling the smelt and so fat that it makes an excellent torch, and is so used by many tribes in British Columbia and Alaska. It burns well without a wick, but some tribes insert a wick of bark. The candlefish is also an important food resource of the Indians.

"I have never seen any fish half as fat and as good for Arctic winter food as these little candlefish. It is next to impossible to boil or fry them, for they melt completely into oil. Some idea of their marvellous fatness may be gleaned from the fact that the natives use them as lamps for lighting their lodges. The fish, when dried, has a piece of rush pith or a strip from the inner bark of the cypress tree (*Thuga gigantea*) drawn through it, a long, round needle made of hardwood being used for the purpose; it is then lighted and burns steadily until consumed. I have read comfortably by its light; the candlestick, literally a stick for the candle, consists of a bit of wood split at one end, with the fish inserted in the cleft." [46]

---

[44] Book 4, ch. 4, p. 9.

[45] Strabo Causab. 468. Book 93, 613. 185.

Candlefish are taken thus by the native fishermen: "To catch them the Indians use a monster comb or rake, a piece of pine wood from 6 to 8 feet long, made round for about 2 feet of its length at the place of the handgrip; the rest is flat, thick at the back, but thinning to a sharp edge, into which are driven teeth about 4 inches long and an inch apart. These teeth are usually made of bone, but when the Indian fishers can get sharp-pointed iron nails they prefer them. One Indian sits in the stern of each canoe to paddle it along, keeping close to the shoal of fish; another, having the rounder part of the rake firmly fixed in both hands, stands with his face to the bow of the canoe, the teeth pointing sternwards. He then sweeps it through the glittering mass of fish, using all his force, and brings it to the surface teeth upwards, usually with a fish impaled, sometimes with three or four upon one tooth. The rake being brought into the canoe, a sharp rap on the back of it knocks the fish off, and then another sweep yields a similar catch." [47]

Bishop Bompas writes that: "In the forests of British Columbia there is one sort of cedar so full of rosin that chips cut out of its green wood in a storm will ignite and blaze at once on applying a match to them. The oolakan or candlefish is also so full of oil that if lit at the tail it will burn like a candle." [48]

The tail of the dogfish is cut into strips and burned for light by fishermen on the Banks of Newfoundland. About 1880 the Penobscot Indians burnt as a torch the body of a fish of some species caught in the Penobscot River, Maine. The Indians thrust a porous root into the fish as a wick.[49]

The Algonkians and Abenakis made torches of combustible wood or rolls of birch bark, or some other gummy tree.[50]

Lafitau says, in speaking of the use of nuptial torches by the ancients and Indians: "No one is ignorant of the fact that during many centuries before they had begun to use wax and tallow for light the common torches were pieces of very combustible wood of pine or other kinds of wood like it, as in the East Indies the bamboo, and in South and Central America the 'bois de chandelle.'" [51]

Archeological work in the caves of Kentucky brought to light torches of cane charred from the effects of burning. The Louisiana Indians tied dried reeds in bundles, stuck them in the ground, and set them on fire when a good light was needed. In America, also, the torch had an extended employment in fishing. In the birch area rolls of bark were the common torch, and in other localities material best suited for the purpose was used. On the settlement of America the basket torch was introduced. The basket torch or fire basket was used by New England whalers and fishermen, and in it was burned cut-up dogfish like pine knots. Whalers also burned the refuse left after drying out whale blubber. The iron basket was hung over the ship's side for light while cutting-in whales at night.

---

[46] J. K. Lord. The Naturalist in British Columbia, vol. 1, London, 1886, pp. 93–94.

[47] Idem, vol. 1, pp. 90–91.

[48] W. C. Bompas. Northern Lights, London, 1886, p. 33.

[49] Information by Dr. C. A. Norton from personal observation.

[50] Lafitau. Moeurs, vol. 2, Paris, 1724 p. 158.

[51] Idem, vol. 1, p. 578.

About 1840, in Fairfax and Prince William County, Virginia, a house light of a primitive character was used in out-of-the-way places. It consisted of a piece of sheet iron bent up at the edges and stuck in the side of the huge old stone chimney of the period, and on this pieces of pine wood were laid and burnt (pl. 33. fig. 14). The children kept up the fire while the women sewed, spun, quilted, or knit.

MEXICO

In Mexico, among the tribes where the arts of life were advanced torches of a superior quality were made, while among the less advanced simplicity was the rule. "The Lacandons used a fir stick in the house for light.[52] In Sonora the Indians used the bark of the *Jacquinia pungens* Gray to make torches. The folk name of the plant is San Juanico (pl. 33. fig. 13). An excellent torch was made from the bark of the ocotillo, *Fouquiera splendens*. Among the Mohave, who are cremationists, when a man dies far away from camp, a small figure of him is made of ocotillo and burnt for him by substitution.[53]

The codices give pictorial evidence of the manufactured torch. The representation of the tapir god in the Codex Cortesianus bears in its hand a skillfully constructed torch. Some detail as to the manner of making torches is given by J. Sanchez:

"The Mexicans split up the wood of the *Pinus teocote* Scheid into thin slivers, fixed them at one end and lighted them at the other for illuminating their houses."[54]

John Fiske says that resinous torches were used for lights in houses in the city of Mexico, and Bancroft writes that besides torches fireflies were sometimes so used.[55]

For illuminating their pathway along the subterraneous caverns of northwestern Yucatan to the sources of water supply, the modern Indian women make torches of cactus stems and bundles of grass.[56]

Sahagun records: "The young soldiers already experienced in war, who they called 'tlelpochtequinaque,' carried the bundles of inflammable pine before these personages when they danced. These bundles were very heavy and made the porters bend under their loads. On them fell sparks, and sometimes the torches slipped out of the hands and fell on the ground in burning. Besides these on the two sides of the parcours they lighted with torches of resin which they called 'tlemaitl'."[57]

---

[52] H. H. Bancroft. Wild Tribes, vol. 1, 1874, p. 697.

[53] Information by Dr. Edward Palmer.

[54] Anales del Museo Nacional de Mexico, vol. 3, 1911.

[55] John Fiske. The Discovery of America, vol. 2, 1892, p. 267. H. H. Bancroft, vol. 2, p. 573.

[56] H. C. Mercer. The Hill Caves of Yucatan, Philadelphia, 1896, fig. 35.

Observations made by the writer at Oaxaca, Mexico, in 1899, reveal the perpetuation of simple methods of lighting from the earlier times. Here the bread market extends into the night, and women bread sellers sit along the street with baskets of their product before them. The lights are little tin lanterns with small panes of glass, candles set up on rings of bread, and splints of *ococote*, fat pine, laid on a stone, brick, or tile often set up on a tripod made of sticks. Vendors of fat pine sit in the market and split the wood with a large knife or machete. A small bundle is sold for 1 cent. *Amole*, yucca-root soap, and firewood are dealt in by poor and distressed persons.

WEST INDIES

The natives of Guanihani were in the habit of using artificial illumination. Columbus from the deck of his caravel, first reported this. Herrera says: "It appeared like a candle that went up and down, and Don Christopher did not doubt that it was a true light and that it was on land; and so it proved, as it came from people passing with lights from one cottage to another."[58]

In the island of Cuba Columbus' men met many persons, each carrying a fire brand in his hand to light fire and perfume themselves with some herbs and to roast their roots, that being their principal food; and the fire was easily kindled because they had a sort of wood which if they worked one piece against another, as if they were boring a hole, took fire.[59]

In Porto Rico the Carib Indians used the wood of tabanuco, a resinous palm, for torches.

De Rochfort gives *toule* as the Carib word for candle, and says "it is of a sandal which yields a gum."[60]

Dr. J. Walter Fewkes brought torches of resin folded in palm spathe from Porto Rico. These torches suggest those of the East Indies, but those mentioned by De Rochfort in 1665 were not introduced from that area (pl. 33, fig 5).

CENTRAL AND SOUTH AMERICA

Of the Isthmians it is said: "At night as a light for their dwellings they use torches made from palm and dipped in oil and beeswax."[61] Humboldt mentions the use of copal torches by the natives of Venezuela.[62] It would be expected that in tropical America resin torches like those of the East Indies would occur. Humbolt also writes:

---

[57] B. Sahagun, London, 1830, p. 121.

[58] Dec. 1, Book 1, chap. 12.

[59] Herrera. History of America (Stevens), London, 1725, vol. 1, p. 56.

[60] Hist. Nat. et Moral des Iles Antilles d' Amerique. Rotterdam. 1665.

[61] H. H. Bancroft. Wild Tribes, vol. 1, p. 765.

"Long before chemists had recognized small portions of wax in the pollen of flowers, the varnish of leaves, and the whitish dust of our plums and grapes, the inhabitants of the Andes of Quindin made tapers with the thick layers of wax that covers the trunk of a palm tree (*Coroxylon andicola*)."[63]

In the Penny Magazine for May, 1832, (p. 212), is a reference to torches of caoutchouc. It is said that the natives make torches of caoutchouc and that one of these 1½ inches in diameter and 2 feet long will burn 12 hours. Caoutchouc was used in sacrifice as incense to certain gods in Mexico.

EUROPE

Most interesting survivals of an age when torches were important are found in Europe. They present forms of the torch of the highest art and of striking simplicity, reflecting the cultural and uncultured periods. An example of the minimum light use is observed in Lapland:

"They were all much astonished at the sight of lucifer matches. As for them, they had no candles, but when they wanted a bright light they held up a piece of burning wood taken out of the fire."[64]

The Shetland Islanders use the excessively oily body of the stormy petrel, *Procellaria pelagica*, as a torch.[65] As a wick is placed in the mouth of the bird touching the reservoir of oil, relationship with the lamp is observed, but the primitiveness of the idea would allow the device to stand at the beginning of either the torch or lamp. At the beginning of every invention there are generally crude experimental or makeshift devices difficult to classify.

"In the Isere, in the Var, in the two Alps, Upper and Lower, the peasants have not even trucks, but carry manure on their backs; they have no candles and burn resinous logs and pieces of rope steeped in pitch. It is the same through all the high parts of Dauphine."[66]

This is a good example of a rude culture area existing in the bosom of a high culture, and Hugo is right in advancing as the causes isolation, mountainous surroundings, poverty of environment and of people. Civilization or enlightenment is as the fringe of fine lines the map makers surround the coasts in proportion to the whole continents of ignorance.

Many of these ancient customs have just been superseded in parts of Europe by modern methods, but still remain as an obscure element in the impedimenta of culture. Thus in 1893 the writer collected a link consisting of a section of fiber rope dipped in resin, in use by the repair gang in a tunnel on a Spanish railroad. It is probable that such lighting device was an immemorial necessity in engineering supplies and had been continued on the list of such supplies (pl. 33, fig. 11).

---

[62] Humboldt. Travels. Bohn edition, vol. 1, p. 257.

[63] Idem, vol. 2, p. 50.

[64] Milford's Norway and her Laplanders, London, 1842.

[65] Ibis, January, 1891, p. 2.

[66] Victor Hugo. Les Miserables, p. 18.

Link holders and extinguishers fastened in the wall near the entrances of great houses still may be seen in London, telling of the time when the city was dependent on links for its lighting. The flambeau of the Middle Ages was a twisted resin or wax soaked torch 3 or 4 feet long. In the Biblia Pauperum, 1410, such a torch is held in the hands of one of the celebrants of the Purification.[67] The flambeau as illustrated in ancient sculpture appears to have been a trumpet-shaped holder in the bell of which were thrust splints of wood. Artemis holds such a flambeau. Properly the torch is a larger flambeau, customarily in Europe made of cord soaked in resin, as in the link. In Scotland an extemporized light was made by twisting or plaiting cotton rags and dipping them in tallow. This torch was called "ruffy," and when butter was used "butter ruffy."[68] The druid's torch is commonly represented of this form. Bog fir was much used in Scotland for torches, and the splints when burnt separately in iron holders were called fir candles. The bog fir was found in the bog by probing. The fat pieces were selected, cut into 3 or 4 foot lengths, and these divided into strips an inch broad by a knife called a fir gullie.[69]

An interesting chapter on obsolete illuminating devices may be gathered from the dictionary. The Spanish word *tea* means candlewood, a resinous wood of any kind that burns like a torch; *teas maritates* hymeneal torches, and *tedéro* an iron candlestick for holding burning fire or torch. The torch of flambeau or cresset type is *antorcha* and *atorchero*, a candlestick for tapers, etc. *Hacha* is a large taper with four wicks, *hacha de viento* a flambeau, torch or link, and *pago de hacha* a link boy also the name of an ancient Spanish dance in which probably torches were borne. *Hacho* denotes a fagot or bundle of feather grass or straw covered with pitch or resin, for outdoor use. *Hachon* is also a large torch made of bass and pitch; it also refers to a kind of altar on which bonfires are lighted for illumination. *Hachero* is a torch stand or a large candlestick for tapers or torches.

Devices for burning a mass of fuel for light were formerly used in Europe. They were stationary, however, and not used as the basket torches of the Near Eart. The fallot, of the fixed type, is a vessel in which pitch, resin, and other combustibles are burnt. They were the street lights of Paris in 1588.

---

[67] J. Ph. Berjean. London, 1849. Book 4.

[68] D. Bruce Peebles. Trans. Roy. Scottish Soc. Arts, vol. 12, 1887, pt. 1, p. 96.

[69] Idem, vol. 12, pt. 1, p. 92.

AFRICA

As stated, Africa outside of the advanced cultured areas around the Mediterranean was entirely in the torch stage. A variety of torches were used but not much information on them is available. The resin torch, is like the East Indian, found in Africa. A specimen 54 inches long was collected at Loango, French Congo, in 1885. The torch is a long cylindrical mass of resin wrapped in palm leaf and encased in cane splints interwoven by a spirally worked strip. It was used by natives when fishing, traveling, or when engaged in fetish rites (pl. 33, fig. 6). A smaller resin torch mounted on a stick is from West Africa (pl. 33, fig. 12). Doctor Verneau, describing his researches in the ancient caves of the Grand Canary, says: "I found fragments of tea, *Pinus canariensis*, a very resinous wood, playing apparently, as in our days, an important rôle in illumination." [70]

In Madagascar torches made of bamboo were used.[71]

In Abyssinia rags dipped in the juice of the *Euphorbia abyssinica* are rolled up for torches.[72]

The torch used by the link boys of Cairo, Egypt, were iron openwork baskets secured to the end of a pole, and sometimes three such baskets were placed on a staff which could be thrust in the ground. In them was burnt flax imbued with resin or pitch after the European method.

JAPAN, KOREA, WESTERN CHINA, MONGOLIA, TIBET

The Japanese employ the torch form of lighting mainly for fishing, and under exceptional circumstances where their elaborate illuminating devices are not available. The Aino burn birch bark stuck in the split end of a stick planted by the fireplace, and also use portable torches. The western Koreans burn bundles of reeds for light.[73]

In the Lob Nor, Chinese Turkestan, Prince Henri d'Orleans found bundles of reeds used for the double purpose of light and fire.[74] At Kholon Fi, southwestern China, Bower says: "However, from a house close by a bundle of canes of a sort that burnt like a torch was procured, and by its aid the halting place was reached at 9.20 p. m.[75] The ever-useful bamboo is used in China for torches. In northern China bamboo is crushed and twisted into a rope, sections of which are burnt for torches.[76] A torch candle was observed by Bonvalot in western Mongolia. A light is thrown on the pot by means of the branch of a tree which has been rubbed with mutton fat to make it answer as a torch.[77] Rockhill describes a Tibetan torch and holder thus: "After dark the room was lit by means of chips of pitch pine burnt on a flat stone, though the usual butter lamps were not wanting."[78]

---

[70] Revue d'Ethnographie, pts. 5-6, 1887, p. 377.

[71] Ellis. Madagascar, New York, 1859, p. 352.

[72] Lindley's Botany. Euphorbia.

[73] W. R. Carles. Life in Corea, New York, 1888, p. 218.

[74] Bonvalot's Across Thibet, New York, 1892, pp. 93-94.

[75] Across Tibet, New York, 1894, p. 248.

[76] Information by W. W. Rockhill.

[77] Across Thibet, New York, 1892, p. 139.

POLYNESIA

That very useful tree called the candlenut tree, *Aleurites toiloba* furnishes material for torches generally in Polynesia, but other vegetal substances are also used. Walpole, speaking of the Tahitians, says:

"The doodoe nuts (*Aleurita triloba*) are strung on palm stalks and stuck upright; the top one is lighted, and as soon as burnt is knocked off as the next catches. These give a poor light and require attention. But they are very plentiful."[79]

In the Society Islands candletree nuts are slightly baked, the shells removed and the kernels strung on rushes. Several strings are wrapped in the leaf of the screw pine, forming a good torch for fishing. Ellis states that in Hawaii four or five strings of the nuts are wrapped in pandanus leaves, keeping them together and making a more brilliant light.[80]

In the Marquesas the burning of the nuts gave a rude approximation to the passage of periods of time.

EAST INDIES

Torches made of dammar gum are generally used within the range of this tree, and the gum is an important article of commerce. Alfred Russell Wallace says that torches of dammar wrapped in the leaves of the fan-leafed palm are sold in the Ternate market. The gum was collected at Langundi.[81]

A simpler torch in the National Museum from Singapore consists of palm leaves smeared with dammar resin and rolled into a cylindrical shape. They are used when traveling at night by the Malays of the Peninsula. The torch is said to give a pretty good light and the smoke has an aromatic odor (pl. 33, fig. 8). Torches of Cambodia and the Malabar coast are described as made of palm leaves tied together and steeped in resin.[82] Torches which burn a short time are frequently made by roughly bunching a palm leaf and allowing it to dry before using.

The Siamese torch is a club-shaped mass of dammar resin 16 inches long, bound up in palm leaf and secured with half hitches of rattan. The lower end is formed for holding in the hand or for socketing in a torch holder (pl. 33, figs 3, 7). From Mindanao comes a dammar torch consisting of a spindle-form mass of resin 40 inches long enclosed in palm leaf and skillfully bound with rattan worked in half hitches so put on that the torch in burning will not come unbound. At the upper end the rattan is twisted in loops for ease in lighting (pl. 33, fig. 4).

---

[78] Journey Through Mongolia and Tibet. Washington, 1894, p. 341.

[79] Frederick Walpole. Four Years in the Pacific, vol. 2, London, 1849, p. 312.

[80] Polynesia, vol. 4, London, 1859, p. 375.

[81] Malay Archipelago, New York, 1860, pp. 346–349.

[82] Popular Science Monthly, January, 1887, p. 316.

Among the Bagobo of Mindanao, Philippines: "As soon as the sun set great torches of almaciga (gum mastic) were lighted and placed in crude but ingenious candlesticks round the circle. The candlesticks were nothing more than three-pronged tree forks, which when laid on the floor left one prong sticking up. This was split at the end and the torch inserted at the necessary angle to insure its burning."[83]

The Bagobo of Davao, eastern Mindanao, also make after the Polynesian fashion torches of viao nuts, which the natives use as candles by impaling a dozen or so of them upon a slender piece of bamboo. These nuts are so full of oil that they burn readily.

The Burmese use a torch made by wrapping rotten wood soaked with native rock oil in palm leaf. It is bound as the dammar torches with rattan withes.[84] A Burmese resin-bundle torch is shown in Plate 33, Figure 2.

Dammar torch holders of several forms are found in the East Indies. The Dyaks of Long Puti, Borneo, construct a cylindrical basket of of bamboo for holding dammar torches kept constantly burning beside the dead.[85]

In Simalur Island a torch chandelier is hung up in houses, and in Nias Island the dammar torch is clamped between two strips of wood held in a wooden upright arising from a base. Torch holders variously devised are common in the Philippines.

AUSTRALIA AND NEW ZEALAND

In Australia torches are made of bark or grass and used by the aborigines when they travel at night. They are afraid of the dark.[86]

Along the coast of New Zealand the mutton fish is burned as a torch.[87]

CANDLES

The use of a wick separates the candle from the torch. It is suggested that the development of the torch at its proximal stages shows inventions which may be regarded as prototypes of the candle, but the development of the essential wick is never obscure. Beyond doubt the wick is a result of many experiments during the stage when the torch was being modified to produce a less objectionable light in confined spaces, as in a habitation.

---

[83] Phelps Whitmarsh. The Ascent of Mount Apo, The Outlook, New York, Mar. 23, 1901, p. 679.

[84] Information by Rev. L. M. Luther.

[85] Carl Bock. Head Hunters of Borneo, London, 1881, p. 142.

[86] Information by Carl Lumholtz.

[87] Information by I. B. Millner.

The candle diverged from the stem of the torch at a relatively late period. It represents, like the torch, the employment of a rigid material for combustion, and differs from the torch in having a central wick made of a capillary substance The capillary wick marks an important epoch in the history of illumination. Tribes having the large domestic animals or having bees or wax-yielding palms and insects in their environment can secure the materials and may invent the candle. A great number of tribes, however, possessing some of these essentials did not make candles. The candle is rather high in the scale of invention, and appears when conditions of social advance permit or require its use; for instance, as in the definite and established culture of the Iron Age.

The candle may be defined as an aggregation of fixed fat or waxlike substance around a central wick. The suitable substances are the solid fat of animals, mineral, animal, and vegetable wax, or even resins, which melt easily and offer a fluid supply to the wick. The latter draws the fluid to the flame by capillarity.

Latitude and elevation furnish temperature elements which are important in the question of the origin and use of the candle. Matthieu Williams, the distinguished English chemist who sought to popularize scientific facts, pointed out that there is an imaginary line crossing Europe which he called the "oil and butter line," an isotherm above which fixed fats occur and below which oils occur. This noteworthy generalization shows the bearing of temperature on the use if not the invention of the tallow candle, and is good also for Asia. The wax candle is not subject to the law of temperature affecting tallow, and is therefore used in warm climates. Beeswax, on account of superstitions regarding bees, its small amount, cleanliness, burning qualities, and pleasant oder, became appropriated for cult purposes. There is no objection to the theory that the wax candle and tallow candle originated from the torch stem independently.

Accompanying the torch and candle are fixtures for installing the illuminant. These grow in complexity as the science of illumination progresses, and have a remarkable development which will be noted in another section.

KINDS OF CANDLES

There are two classes of candles whose genesis can be traced. The first of these is the taper, which is a cord or wick covered at present usually with wax, forming a flexible length suitable for coiling in a vessel or around a support. The taper is recognized in forms of the torch made up of manufactured parts instead of rude natural materials. Thus the European torch of considerable antiquity was an aggregation of cords imbued in fat, wax, resin, and the like, bound or twisted as the link rope, and units of this torch were used as tapers.

In America the taper was called during the Civil War, "Confederate candle," and because the light required frequent attention the humorous slaves dubbed them "pull ups." Dr. C. A. Q. Norton relates that during the Civil War he attended a dance in a hall lighted with coiled tapers. Tapers are still used in the mountains of Virginia and are sometimes elaborately wound in ornamental patterns (pl. 33, fig. 10). Tapers were presumably introduced into the colony from England, where this form of lighting was well known among the peasantry. The coiled taper was widely used in Europe and is still common in Russia. It is found in use in the Catholic churches in Latin countries. Many artistic forms of taper holders were formerly found on writing cabinets in employment for sealing letters.

The second form is the familiar rigid candle, a lighting device of respectable antiquity. The Romans are said to have sometimes made candles by dipping strings of papyrus or rushes in pitch and surrounding them with wax. Pliny says that wax and tallow candles were employed in religious offices.

In northern Europe the rush was found to be an ideal wick for the candle, and rush candles became well known. Previously also the rush was partially peeled and soaked in fat, making the rushlight approach the taper class. Holders for the rush were known as rush clips. In Ireland a splint of bog fir dipped with tallow was said to have been used as a candle.

Another species of candle is found in Korea, Japan, China, and adjacent countries. The wick is of rush pith wound on a straw or twisted paper spill. A slender tapering stick or splint of bamboo is run through the tubular spill and a mass of fat formed over it. In Canton these candles are called lobstocks. In Korea and Tibet the supporting stick extends below the candle for convenience in carrying and for placing in a candlestick. A ruder candle of this sort is from Mongolia (pl. 33, fig. 9).

At the time when chemical and industrial science had perfected and had rendered the candle a relatively important factor of civilization other discoveries in illumination automatically thrust it into a lower place. Conservatism of custom, particular needs and demands not formerly reckoned with, as art, have prevented the candle from becoming obsolete. At present the candle enters into the scheme of illumination as a wasteful method but gratifying the esthetic sense.

It is concluded that the candle is an invention belonging in an advanced plane of culture, hence presence of the candle among uncivilized tribes is to be looked upon with suspicion of extra origin. The Tapuyos of Brazil use tapers of beeswax and bark fiber.[88] Dr. Daniel G. Brinton says: "If this is one of their ancient arts, it is the only instance of the invention of an artificial light south of the Eskimo in America."[89]

---

[88] J. Von Tschudi. Reise in Sud Amerika, vol. 2, Leipzig, 1866–1869, p. 281.

CANDLE MAKING

Materials.—Vegetal and animal substances are principally the materials used in making candles, mineral substances, as paraffin, coming late into the candle industry. In the eastern United States candles made from the wax of the bayberry, *Myrica cerifera*, were in vogue in the colonial and Revolutionary period and later. Beverley says:

"At the mouth of their rivers, and all along the sea and bay, and near many of their creeks and swamps, grows the myrtle, bearing a berry, of which they make a hard, brittle wax, of a curious green color, which by refining becomes almost transparent. Of this they make candles, which are never greasie to the touch, nor melt with lying in the hottest weather. Neither does the snuff of these ever offend the smell, like that of a tallow candle, but instead of it yields a pleasant fragrancy to all that are in the room; insomuch, that nice people often put them out on purpose to have the incense of the expiring snuff.

"The melting of these berries is said to have been first found out by a surgeon in New England, who performed wonderful things with a salve made of them. This discovery is very modern, notwithstanding these countries have been so long settled.

"The method of managing these berries is by boiling them in water till they come to be entirely dissolved, except the stone or seed, which amounts in quantity to about half the bulk of the berry, the biggest of which is something less than a corn of pepper."[90]

In Demerara also candles equal to wax were made from the seeds of a large tree called dali, *Virola sebiflors*. A myrica in northern Granada and Peru yields candle wax. The wax of the *Klopstockia cerifera*, carnauba of northern Brazil, and the Ceroxylon or wax palm was used for candle making.

In India and the Far East the vegetable wax industry is quite extensive. The Japanese make candles from the wax derived from seeds of several species of the ourushi or lacquer tree, *Rhus succodanea*, and others of this genus. In China vegetable wax is procured in commerical quantities from the seeds of *Stillingia sebifera* and *Croton sebiferum*, the latter called the tallow tree in India, where it also is an important source of wax.

Animal fats in candle making.—Before the era of chemical and technical science the fat of cattle and sheep was used in only a slightly modified state to make candles by domestic industry. On the establishment of the whaling industry spermaceti from the head oil of the sperm whale, *Physeter macrocephalus*, was added to the mentioned fixed fats.

---

[89] The American Race, New York, 1891, p. 238.

[90] Beverley's history of Virginia, 1722, pp. 119–120.

Insect waxes used for candles.—Beeswax appears to have an ancient history in the manufacture of candles as tallow, was more prized and had special uses not enjoyed by fat illuminants. Bees were anciently domesticated, as the straw hive of the early Aryans indicates. The wax had a number of uses, but there is no record of its employment for candles at an early period.

Another insect wax is of economic value in China. This wax is the product of *Coccus pela* Westwood, a scale insect breeding on *Ligustrum lucidum*, a large-leaved privet, and transferred by the Chinese to sprouts of the *Fraxinus chinensis*, from which the wax yield is gathered in three months. The center of the white-wax industry is Chien Chang, western China.[91]

Mineral substances for candles.—A natural paraffin called ozokerite, found principally in Galicia, is refined and the product, called cerasin, is used for making candles.[92] Paraffin as a by-product of the distillation of petroleum is secured in enormous quantities and is now the chief resource of material in the candle industry.

Candle-making processes.—The candle-making industry has attained great proportions, and even with the competition of advanced illumination is still flourishing. Curiously, the increasing employment of candles in decoration has done much to sustain the industry. The product, however, is taken mainly by the churches. Without consideration of the modern organized industry, candle making as a local or domestic art will be taken up here. In domestic candle making little was done in the refining of materials, the physical and chemical properties of which were not known. The method of hardening or softening the tallow was almost the only attempt to change the material. There was a minimum of trade in candles, chiefly that arising from the exchange of family surplus for goods.

Formerly in the United States candles were made in molds and by dipping. The latter method was used when quantities of candles were required, enough for a year's consumption or more, as it was thought candles improved by keeping. Molds were used for small lots of well-shaped candles and by people who had little tallow, it was said.

In making dipped candles a number of thin rods were gotten. These were strung with cotton wicks previously cut to proper length on a cutter and twisted. The wicks were "wet" with tallow to make them sink when dipped and were spaced on the rods. The rods were laid across a frame sometimes improvised or a mortised structure made for the purpose. The tallow rendered by boiling and straining was placed in a large crock the depth of a candle. As the tallow was used water was poured in, and thus the tallow could be used up.

---

[91] Alex Hosie. Three years in western China. London, 1890. Nature, January 29, 1891, p. 291.

[92] George P. Merrill. Non-Metallic Minerals, New York, 1910.

The dippers began by separating the rods to each end of the frame. The crock was set between them and one dipped with the left hand the other with the right. They dipped, the wicks and placed the rods back of those not dipped, continuing till the candles were of the proper size. As the dipping was done in the cool autumn weather, very little grease was spilt and the candles would "dry" rapidly. Newly dipped candles were as yellow as beeswax, but after lying awhile in the dark candle box they became bleached. When the candles were throughly cooled they were squared at the bottom by passing them carefully over a skillet inverted over hot coals. Near the latter part of the dipping candles became too large at the butt. These were reduced by swinging them through the hot tallow. The final act was to trim the wicks and store the candles in tight boxs. The rush makes an excellent wick because it burns to ashes and does not require snuffing. It could be used for dipped candles but not for molded candles, as it was not strong enough to draw. In Ireland a boat-shaped iron dish called grissette was used for dipping candles. It was set on the earth and candles were dipped when needed. Wax candles were almost invariably made by hand, by pouring melted wax on the wick from a ladle or by drawing through a die in making tapers. The earliest method was forming the softened wax around the wick by hand manipulation, and finishing by rolling. The ladle method came later, and the drawing method later still. Flambeaux are described as being constructed of four wicks covered with wax laid together and wax poured on them, then smoothed by rolling. In the developed candle industry wax candles are made in molds. Candles in Japan, Korea, and China were molded in paper tubes set on a board pierced for the rod holding the coiled wick. Candles of soft material were coated with a layer of beeswax by dipping.

Candlewicks.—It has long been recognized that the efficiency of a candle depends upon the character of the wick, the criteria being size, construction, and combustibility. The domestic art had worked out its formula in the number of threads in the cotton wick, the advantage of a half cotton and half flax wick, the improvement of the wick by twisting, and the value of a flat braided wick which curves over out of the flame. Franklin's discovery of the light given by two juxtaposed flames was applied in the two-wicked candle called "cobbler's candle." About 1845 a candle with a hollow wick was invented, following, no doubt, the idea of the tubular lampwick increasing the aeration of the flame. The Soho candle lamp of this period was of this order, but the wick was raised or lowered by a rack and pinion at the base of the candlestick. Before 1847 Palmer invented a wick which had one-tenth of the strands coated with nitrate of bismuth, which caused the burnt end of the wick to curl over.

Candlesticks.—In the torch stage holders are not a pressing need. The torch is a rather temporary form of illumination employed mainly for night travel and was carried about by a delegated bearer. In ceremonies and about habitations improvised holders became necessary. The resin torch, which shows a marked advance on the bundled torch, begins to be accompanied with designed holders. Thus in the Malay area are found torch stands and even a torch chandelier. There is doubtless a line of these holders up to the candleholders of China. In Europe the torch splint for household use, dating from the Iron Age, introduces a series of devices which may be graded thus: A flattened loop bent in an iron strip, a V-shaped prong acting as a grip and support for the splint; a hinged clip resembling tongs; a hinged clip and candle socket combined; and a socket candlestick alone. This is suggestive of the lineage of the socket candleholder (pl. 34. figs. 1–5).

Rude candlesticks of wood, like those from Finland shown on Plate 35, Figures 1 and 2, are examples of the simple domestic art of the frontier or of formerly much isolated communities. The iron candlestick from Pennsylvania (pl. 35, fig. 4) was commonly found in rural districts of the eastern United States in the eighteenth and nineteenth centuries.

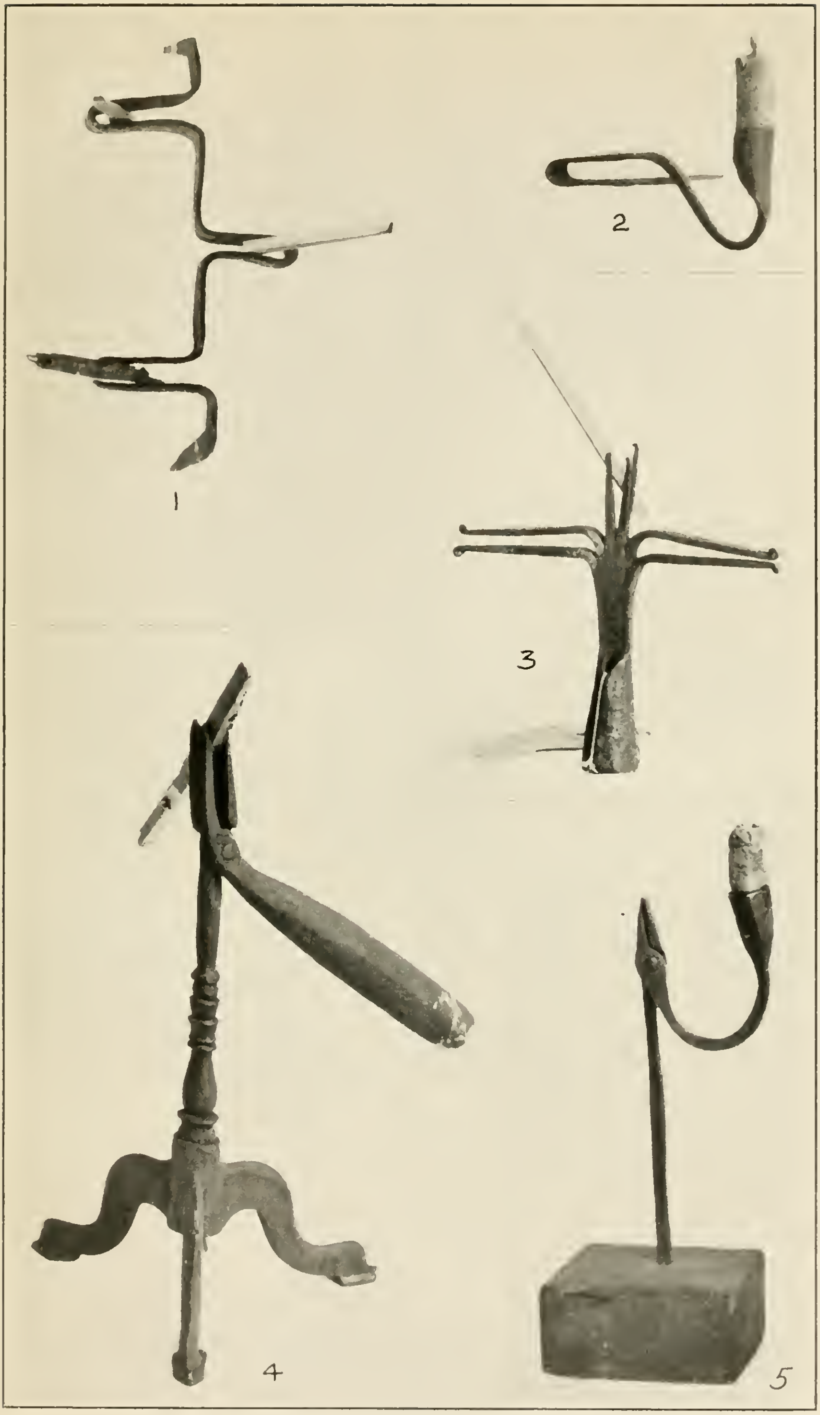
The pricket candlestick appears to descend from the torch holder set in the walls of old castles (pl. 35, fig. 3). Antique church candlesticks, especially the large altarpieces, had the spike, either a survival of an earlier torch stand or required by art; that is, a socket for a large candle would force bulkiness in the stem and base of the candlestick and destroy the harmony between the candle and its holder. The spike also is adequate for the placement of a candle not to be moved about, but the socket is necessary for ambulant candlesticks.

A well-carved square tablet of oak soaked with grease and having an irregular hole burnt in the middle, found in the hull of an ancient Viking ship dating 800–1000, is identified as a candlestick. Several of these, more or less charred, were found. There was no socket present, and it is probable that the candle was set up on a nail or peg.[93]

The taper holder is of two varieties, the one a bowl or reservoir in which the cord is coiled, and an upright around which the coil is wound. In the Russian taper holder the bowl is mounted on a stem with base, and thus resembles a lamp, as the specimen in the church

---

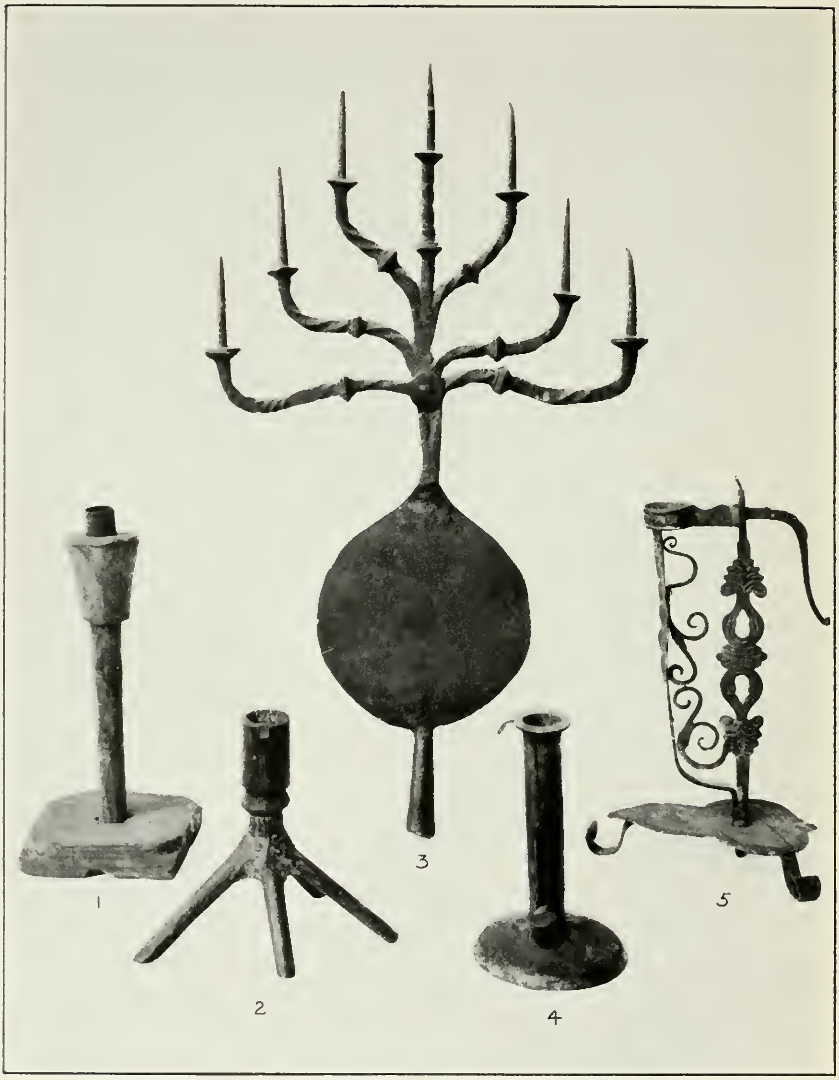
[93] Scribner's Magazine, November, 1887, p. 613.



SPLINT AND CANDLE HOLDERS

1. Finland; 2, Device for splint and candle, Finland; 3, Splint holder for staff, Czechoslovakia; 4, Splint holder with weighted arm, England; 5, Candle and splint holder, England

FOR DESCRIPTION OF PLATE SEE PAGE 214



CANDLE HOLDERS

1. Wooden candlestick, Finland; 2, Branched candlestick, Finland; 3, Pricket processional iron candlestick, Europe; 4, Iron candlestick, Pennsylvania; 5, Spring candlestick, 1709, Germany

FOR DESCRIPTION OF PLATE SEE PAGES 214 AND 215

at Sitka shows. The taper holder has no relationship to the candlestick.

Of the two types of candle placements, namely, the prickets and socket, the latter has survived as the common form, while the pricket, if ever in general use, became obsolete in the seventeenth century except as stated where continued in use in churches.

In the great variety of candlesticks as to material, art, nationality, period, use, and so forth, there are a number of improvements or modifications which may be classed as minor inventions. These are seen in the flared rim of the socket for catching the grease; extension of the socket into a tube, stem and slide by which candle may be raised and butt ejected; expansion of the base into a dish; raising or lowering device on a stem; modification of stem and base into a spike for thrusting into wall or wood or into hook for hanging on a peg; attachment to a sconce plate for hanging on a wall. For special uses there have also developed the brewer's candlestick, the weaver's, the miner's, the pocket and folding candlestick, and the numerous varieties of every material suitable for palace, church, parlor, kitchen, and other divisions of the house.

The mounting of the socket is quite as variable, as seen in candalabra, girandoles, chandeliers, brackets, sconces, and on jointed arms for extension, etc. Special candlesticks of German invention in the eighteenth century in one case have the socket sliding on the openwork spiral stem, and in the other the candle clamped against a half socket by a spring forming the other half. The latter device may have descended from the torch-holding forms of the Iron Age (pl. 35, fig. 5). An invention of about 1840 by the Englishman Palmer placed a spring under the candle, forcing it up steadily as the fuel was burned away at the top. This took the place of the older rod which served to force the candle up.

There have developed with the candlestick many petty inventions, either utilitarian or refinements. Some of these are extra sockets or prickets for burning candle ends, called by the French *brule tout;* the socket cup, allowing the candle to be lifted out of the usual socket; glass or metal disk for ornamenting the top of the candlestick, and others. An interesting device consists of an individual socket with spreading teeth which when forced down into the socket clamped the candle firmly.

Reflectors and shields, which were often applied to the candle, came at a comparatively late period. In some cases, as in the Washington candlestick, which may have been used in writing the farewell address, the broad brass plate against which the candle sockets are mounted was intended to guard the light from the wind and was not a reflector. An adjustable shield for keeping the light out of the eyes was sometimes used. Large ornamental glass globes for shielding the candle, called "hurricane globes," "guarda brieza," were used in the great mansions. Sometimes a flaring glass shade was applied to candlesticks furnishing the best rooms of houses.

Candle lanterns.—When the candle was required to be used in the open air, or carried about outside, or transported on vehicles and boats, a protection either transparent or perforated was required. The lantern responds to this need. The earliest lanterns were candle lanterns, and in the course of the development of illumination every species of lighting apparatus has been installed in this device. In the Orient the lantern appears to have been anciently used. In England King Alfred is given credit for inventing the lantern to insure the steady burning of his time candles. In Egypt there was discovered a drum-shaped perforated hanging lamp of bronze, questionably of the ninth century.[94] The oiled paper or transparent paper lantern has a wide distribution from the Near East to the extreme East. It is probably an old form in this region. The perforated lantern as to its grade of invention would precede other forms, but in metal at least is late (pl. 36, figs. 1, 2).

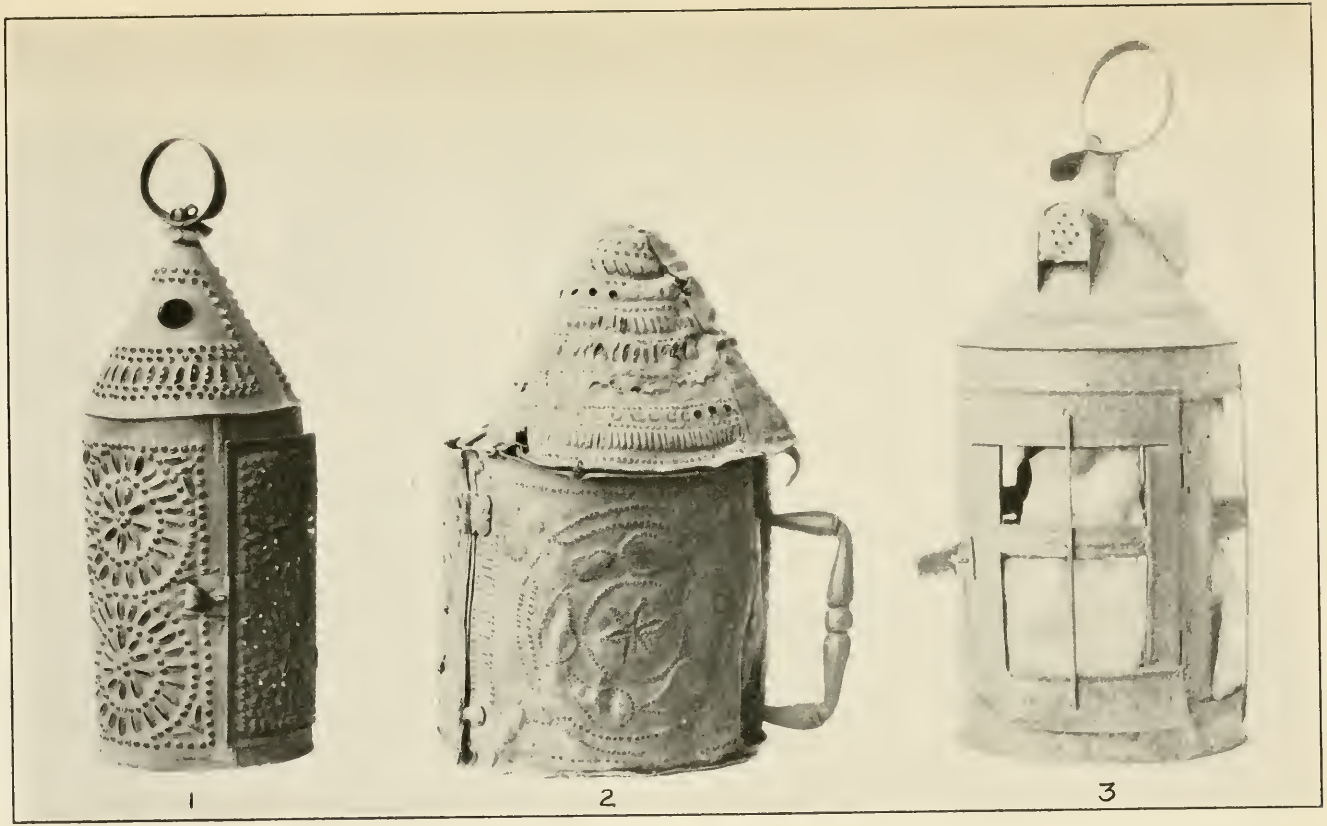
As a comprehensive remark, the lantern and candle are linked as to age and both are developed in a relatively high stage of civilization. The suggestion of shielding the light, leading from the cupped hand to elaborate lanterns, is so apparent that extemporaneous devices are numerous, and these with the elaborate forms may have arisen independently in many places and at indefinite times. Perforations, paper, cloth, skin, horn, mica, and glass were employed to transmit light in the lantern (pl. 36, fig. 3).

Devices for regulating the candle.—Aside from lighters of splints and so forth, ignited at the fire, there are other devices connected with the history of the match (see Fire making). For a long period candles of the uninventive period, with wicks not properly designed, required snuffing, and for this purpose snuffers were invented for the use of those who did not wish to employ the earlier method with the fingers. The earliest snuffers were little rods or pincers with sharp points. The early hinged snuffers were rudely made of iron, the end of the box terminating in the sharp point for spreading and otherwise tending the wick which has been perpetuated in all snuffers. The handles were plain rods. The snuffer was improved by putting loops, as in scissors, on the ends of the handles, by putting in a spring which withdrew the damper from the fungus box, and by the addition of thin legs to stand upon the tray. A later device exhibits a spring diaphragm which shuts the fungus, charred wick, into a tight compartment.

In the progress of refinement snuffers became art works of the metal workers, and trays equally artistic were provided on which the

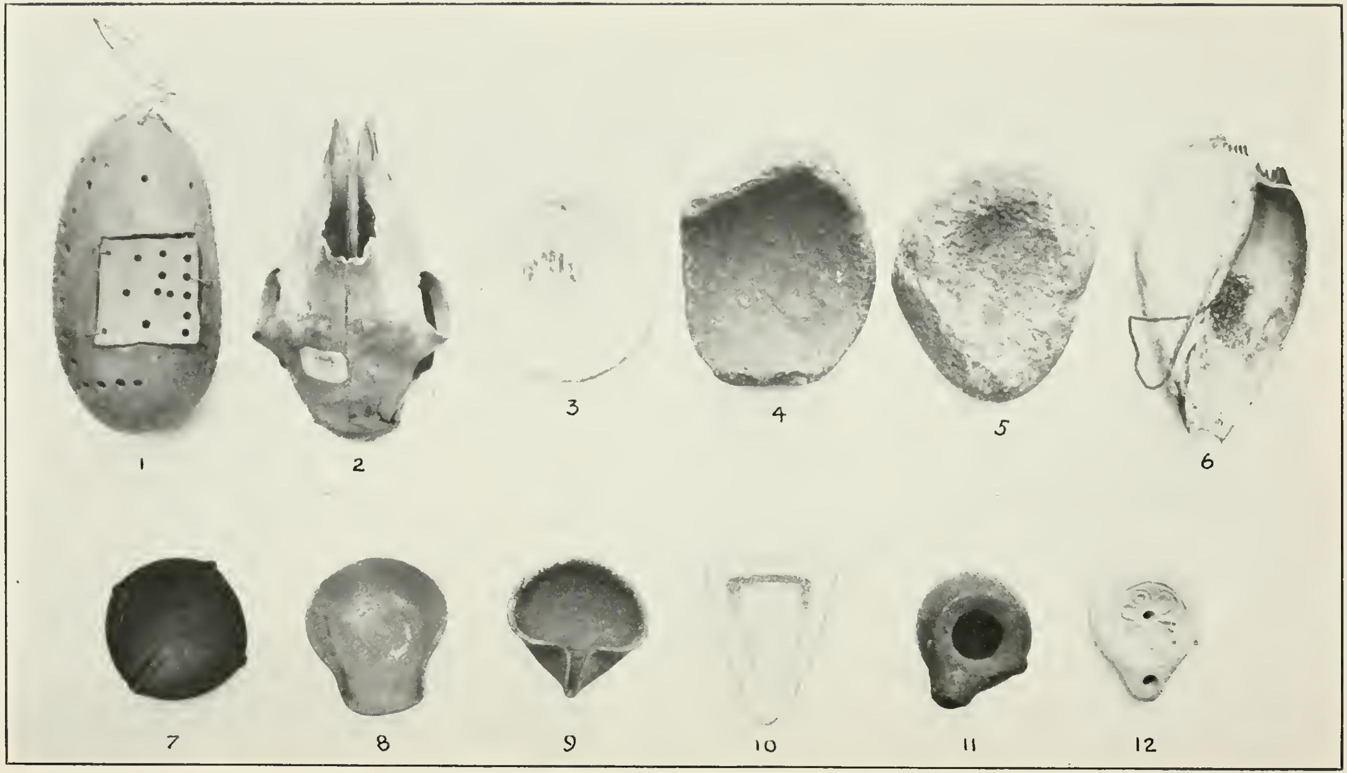
---

[94] Robert de Rustafjaell. The Light of Egypt, London, 1909, pl. 36, p. 79.



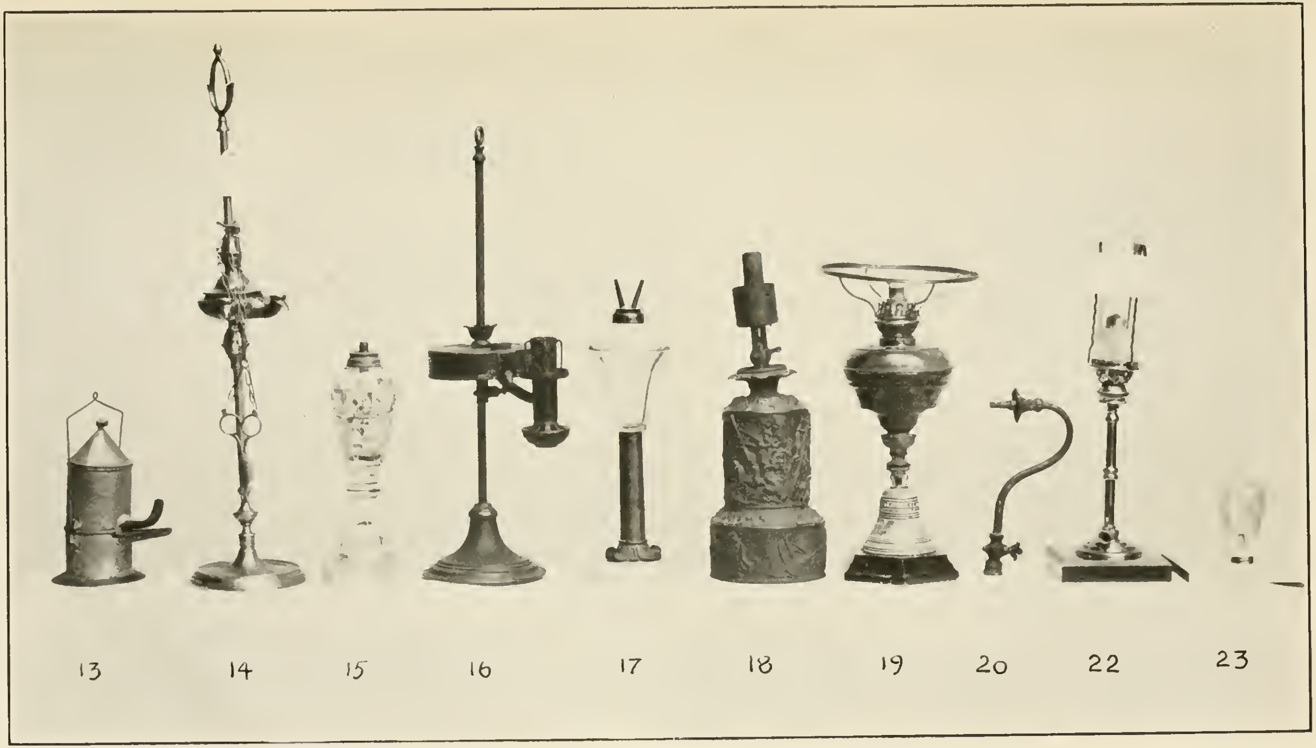
1, PERFORATED IRON LANTERN, UNITED STATES; 2, PERFORATED COPPER LANTERN, ITALY; 3, LANTERN "GUY FAWKES" WITH HORN PANES, ENGLAND

FOR DESCRIPTION OF PLATE SEE PAGE 216


1
2
3
4
5
6
7
8
9
10
11
12

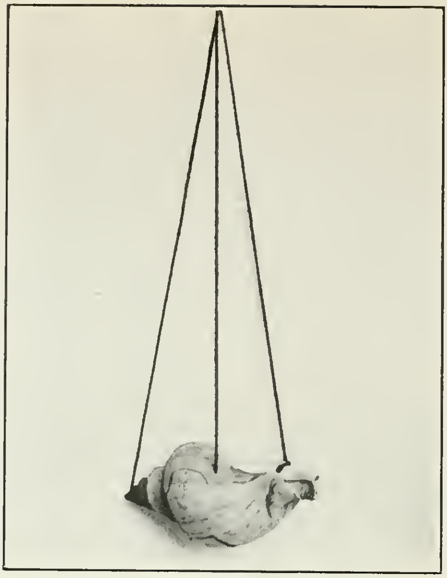
DEVELOPMENT OF THE LAMP IN SIMPLE FORMS

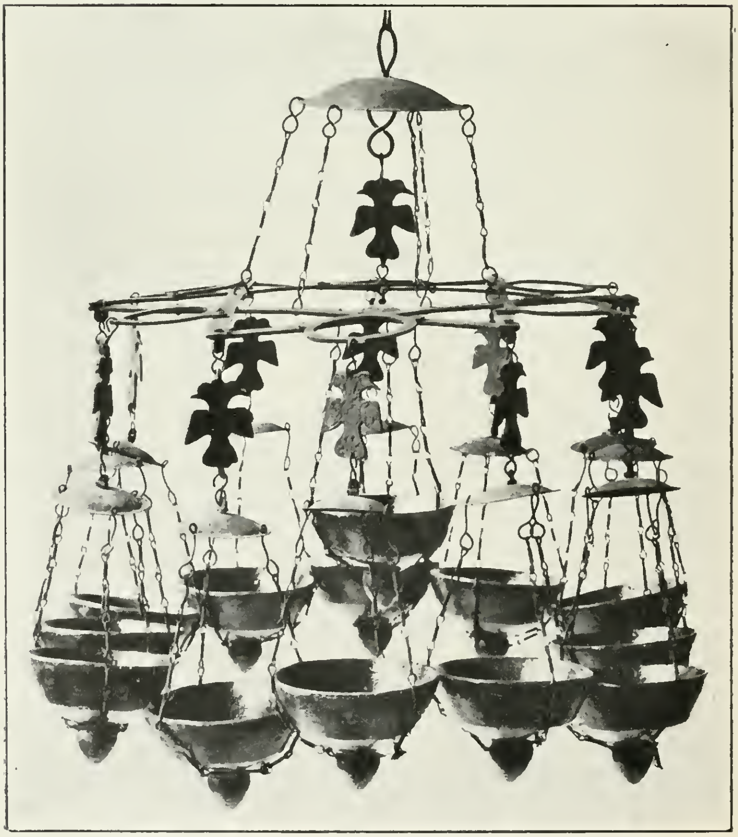
FOR DESCRIPTION OF PLATE SEE PAGE 217


13
14
15
16
17
18
19
20
22
23

DEVELOPMENT OF THE LAMP IN ADVANCED FORMS, TO ELECTRIC LAMP

FOR DESCRIPTION OF PLATE SEE PAGE 218





SHELL LAMP AND HANGING SAUCER FLOAT LAMP

Top, Orkney Islands; bottom, Tetuan, Morocco

FOR DESCRIPTION OF PLATE SEE PAGE 218

snuffers were rested. Snuffers have, however, become entirely obsolete on account of the development of scientific wicks which do not require snuffing.

Extinguishers.—These cones of metal, with loop for lifting or prong for fitting into a socket on the candlestick, follow a similar art development observed in the snuffers. There was very little possible play of invention on the extinguisher, and there is only noted the invention of an arm bearing a cone which was mounted in such a way that when the candle burnt down a certain distance it was automatically put out. For extinguishing tall candles or candles in chandeliers the extinguisher was mounted at the end of a pole.

CUSTOMS CONNECTED WITH THE CANDLE

The use of candles to mark periods of time is according to tradition an invention of King Alfred of England. It is said that by timing by means of the sand glass the combustion of certain amounts of wax, the royal inventor arrived at a standard candle which would burn 4 hours. Twelve divisions marked across then gave 20-minute periods, and six candles covered the 24 hours.

Among the folk the connection of the wasting of the candle and elapsed periods of time would inevitably be noticed, and customs continued from old times in Europe to near the present would indicate that this use of the candle was general. Auctions of land and other material belongings were conducted "by candle." Sometimes an inch of candle was lighted and bids taken while it burned. The last bid made as the candle went out won the land. Frequently a pin stuck in the candle marked the limit of bids; when the pin fell out bids stopped.

DEVELOPMENT OF THE LAMP

Compared with the torch the lamp is a recent invention. The idea of the lamp may have been suggested by the burning of marrow in a bone, of fat in the fire, the oily body of a bird or fish, or other makeshifts in which a wick was not yet used and which therefore would be variants of the torch, bearing on the beginning of the lamp.

Applicable here is the Malay saying, "What is a lamp if the wick be lacking," alluding to the chief essential of the lamp. The lamp consists of a reservoir for holding whatever medium supplies the flame and a wick acting by capillarity.

A series suggesting the chief features in the development of the lamp is exhibited in the United States National Museum, one of a number illustrating the history of inventions. The series is described as follows (pls. 37, 38):

1. Oil bag, from which oil is thrown upon a fire to produce a temporary light. British Columbia.

2. Lamp. Unworked beach stone with concavity, supplied with fiber wick and oil. Aleuts, Alaska.

2. Lamp made from the skull of a sheep.

4. Lamp. Hollowed beach stone with moss wick arranged along one edge. Eskimos, Alaska.

5. Lamp. Pecten shell with oil and wick of rush pith. Aino Japan. Shell lamp suspended, Orkney Islands.

6. Lamp. Terra cotta saucer. India.

7. Lamps. Examples with gutter for wick. Example with several gutters. Syria and India.

8. Lamp. Of terra cotta. Reservoir almost closed over; spout for wick. Roman.

9. Lamp. Of terra cotta. Reservoir closed over; spout for wick. Roman.

10. Lamp. Of brass. Reservoir mounted on rod and stand; several spouts. Italian.

11. Lamp. Designed to furnish oil to the wick under pressure. Cape Cod, Mass.

12. Lamp. Of glass, having two tubes; for burning whale oil. United States.

13. Lamp. With chimney; draught around the wick and oil under pressure. Argand's invention. United States.

14. Lamp. With chimney and Argand burner; oil under forced pressure of a spring. France.

15. Lamp. "Fluid" or camphine burned by means of wick and tubes and without chimney. United States.

16. Gas burner. United States.

QUASI-PRIMITIVE LAMPS

Lamps of rude character appertaining to the prehistoric Aleuts were found in the graves and kitchen middens of the Aleutian chain by Dr. W. H. Dall. These lamps are beach stones, slightly weathered, of convenient size and having a natural concavity. The type specimen shows traces of its use on a portion of the edge where a wick was laid, as in the Eskimo lamp. This lamp would appropriately begin the series. There is, however, no surety that this rude form did not exist contemporaneously with finished lamps in the Aleut area.

Extemporized lamps of sea shells have a logical background in the suggestiveness of the shape of the shell. The shell of *Fusus antiqus* is a case in point, the troughlike extension of the lip of the shell being a ready-made slot for the wick and the body of the shell forming a reservoir when the shell is suspended horizontally. Lamps of the fusus were used in the Orkney and Shetland Islands[95] (pl. 39, fig 1).

---

[95] Information sent by Henry Balfour, Oxford, England.

On the Eastern Shore of Maryland and at other points on the Atlantic coast shells of the *Fulgur* and *Sycotypus*, called conch, were used as lamps for illuminating piers and landings. They are still used when it is desired to give an effect of "old times" to excite the wonder of visitors.

The Makah Indians of Cape Flattery, Washington, are said to have used in 1850 a lamp consisting of a shell with bark wick, but J. G. Swan's paper on these Indians, containing observations made near this date, does not mention the lamp.

The Aino lamp, while not extemporaneous, being in common use, is probably accultural, following the Chinese and Japanese form but using the well-adapted *Mactra lutraria* shell instead of the pottery or metal saucers. The lamp is mounted in a stick split at the end and wedged out to form prongs, or in a natural crotched stick. It is set up alongside of the box hearth. The wick is of rush, as in the Japanese lamps.

In Brittany a pecten-shell lamp was in use some years ago. Following north European custom with the grease lamp, the Brittany lamp is set in a drip catcher consisting of another pecten shell and sometimes had a shell lid as an improvement, giving the lamp the orm of a crusie.

PRIMITIVE FORMS—SAUCER LAMPS

A few small, shallow vessels of stone, thought to be lamps, have been found in several prehistoric stations in France. Some of these are of doubtful age, some Gallo-Roman, and a few, as the St. Julien Maumont (Correge) specimen described by M. Riviere, [96] which are tentatively placed as occurring in a very old period. This specimen is obscurely beaked, which would indicate an unstandardized lamp, in this case of stone, of a comparatively late period. There appears to be no evidence that lamps have been taken from a definite stratum as old as the Neolithic. The presumption is that no European lamp dates back of the Iron Age.

The shallow circular dish termed "saucer" is taken as the primitive type of lamp employed at a time when this form of lighting device had become a customary utensil. In it was burned oil or fat by means of a central wick. If, however, the saucer is very shallow, as the Chinese form, the wick could rest precariously on the margin (pl. 40, fig. 7). In these lamps no adaptation is seen for the placing of the wick. The lamp, therefore, is possessed of a reservoir only, which is the fundamental feature of the lamp.

LAMPS IN WHICH WICK IS BROUGHT TO THE EDGE

Modifications of the saucer lamp are plentiful for the purpose of placing the wick. Examples are the shallow grooves pounded in the Cashmere copper lamps and the bending in of the edge of the pottery saucers from ancient sites in Syria, North Africa, and other localities, modifying features suggesting the beginning of the wick spout (pl. 40, fig. 5, 8). The Eskimo stone lamp devotes a portion of the edge for the lip on which the wick is laid, necessitating the change of the form of the lamp to oval or elliptic. The Eskimo pottery dish lamp remains primitive with no definite placing of the wick.

---

[96] M. Emile Riviere. La Lampe en pierre de Saint Julien Maumont, Comptes rendus de l'Association Francaise pour l'Avancement des Science, Congres d' Auzers, 1893, pp. 1-5.

LAMP WITH BEAK

The next step is in the measures taken to install the wick. By this step the lamp assumed the shape which it retained for thousands of years. This shape is familiar in the classic lamp, which has a circular reservoir and projecting beak for the wick.

The beak also arises in another manner that is germane to the construction of the lamp. The acute triangle form lamp cut from soapstone by the Kashmiri and secured by Dr. W. L. Abbott has the trough continued from the reservoir to the apex of the triangle and related to the shape of the excavation in the vessel. This introduces the pottery lamp in the form of a foot with open wick trough extended as a clumsy spout or beak. The reservoir is closed over, and through the top as through the neck of a bottle oil was poured in. This form is ancient, being sculptured on a stone zodiacal slab of Nazi Maradah, son of Kurigalzar II, about the middle of the fourteenth century B. C. It is also shown on the cap of a kudurru or boundary stone bearing the star emblems representing Babylonian deities.[97] Identical lamps are still in use in Turkestan and Kashmir, and have been found in Mohammedan stations in Egypt, Asiatic Turkey, and Spain. A blue glazed Saracenic specimen of the tenth century from Turkey in Asia is in the National Museum. It is worthy of inquiry whether this form of lamp was introduced into Babylon by the Turanian Cassites, who usurped the government of Tiglathpilesar and who may represent one of the incursions from high Asia. The persistence of this form is truly remarkable (pl. 40, fig. 4).

There is a large class of lamps which appear to trace back to the later Iron Age and which persisted in Europe far into the nineteenth century. The simpler forms are of iron, of long triangular outline with little or no differentiation of reservoir and spout, as in the Kashmir stone lamp. These lamps always have an upright curved iron strap fastened at the back by which the lamp may be lifted or hung up. This lamp is an excellent example of the multiplicity of minor improvements which were applied to a primitive lamp and which at the end still remained a primitive lamp. In the less-modified forms of this lamp the wick gutter was uncovered, and only in the latest was it housed (pl. 40, figs. 1, 6).

---

[97] Paul Carus. Chinese Thought, Chicago, 1907, pp. 92–93

LAMPS WITH WICK SPOUTS

The next considerable step in advance was the employment of lamps having a projecting spout in which the wick was put (pl. 40, figs. 2, 3). Applied to the small classic lamps this feature was not of great practical value, but to larger vessels there was some benefit in the slight fluid pressure on the wick. Fluid pressure on the wick is hinted at in the devices for tipping the simple basin lamps, and this principle was perhaps long unconsciously practiced before it before it became an established usage.

The variation of the wick spout has produced innumerable forms of this development of the edge of the reservoir. The Greco-Roman lamps, manufactured by millions in terra cotta and bronze, can be laid out, irrespective of date or place or reversions, to show stages in the quasi development of the spout, reservoir cover, handle, foot, etc. These series are not useless when considered as indicating a normal genesis of the features mentioned.

A fundamental fact is the covering over of the reservoir, which has its effect later in the development of the lamp. No efforts are seen to cover the reservoir of the circular saucer lamp, as this would defeat its designed use. With the definite placing of the wick and the growth of the beak appear numerous instances of partial covering of the reservoir in primitive lamps, culminating in the complete incasing of the reservoir seen in the classic forms. The wick spout also loses its untidy aperture and is pierced with a symmetrical hole fitted with bronze tube having a collar holding it in place.

Greco-Roman lamps were carefully conformed to the cultured taste of the ancients, who developed this household necessity to a high state of artistic excellence. Limpid olive oil was a lamp fuel by far the best known at the period, and obviated the use of drip catchers characteristic of the lamps of the northern peoples of less culture, whose smoky lamps consumed nauseous fats and greases.

The Greco-Roman nations also made lamps of two and several spouts. These are found in later Roman sites. The Roman lamp spouts show little tendency to depart from the horizontal or to be developed in the sense of a tube curved upward near the end. The wick, as in primitive lamps, was laid in the oil horizontally or inclined slightly and turned up only at the end where it was lighted. The low capillarity of the wicks notwithstanding the limpidness of the fuel was such that a vertical wick was not practicable.

With the fall of the Roman Empire illuminating apparatus again took on the phases of folk art and invention reviving or perpetuating crude types. Glazed pottery, glass, and metal, especially the latter, were increasingly used as materials for lamps. There is noted also an increasing demand for light among the northern nations as culture grew, but inventions which would foreshadow the effective lamp can scarcely be distinguished among the barbarous lights of the Middle Ages.

LAMPS WITH LIMITED GRAVITY PRESSURE

The link in the chain of lamps from the Roman period to the period of enlightened invention is the Italian lucerna (pl. 41, fig. 2). This lamp is of bronze, brass, or terra cotta, and consists of a reservoir with from two to four spouts and an upright stem with base on which the perforated reservoir can be raised or lowered. When the reservoir is full there is a slight gravity head on the oil, not conclusively intentional but which might suggest an improvement to an observing mind. In passing it may be said that the Italian lucerna is the most graceful and beautiful lamp ever designed.

There follow in this apparent line lamps patently designed to to furnish oil to the wick under gravity pressure (pl. 41, figs. 1, 3, 4). This series of lamps is selected from the numerous primitive or quasi-primitive lighting devices of Europe as the one pointing out the way to the practicable lamp. Up to a few years ago these slanting long spout lamps in brass and copper were in use in Belgium, France, and other north European countries. Many came with immigrants to the New World.

In the beginning complexities of researches ushering in the inventive period many experiments were carried on by men whose minds belonged to a new age. The needs for more light were stressed by growing cities, navigation, commerce, occupations, and the vast ramifications of social intercourse. Civic lighting was beginning, and provisions must be made looking toward efficiency and economy in public illumination. There was also evident the remuneration which would follow the appearance of practicable lighting apparatus. The lamp, which for ages had been childishly simple, required for its elevation to the plane of science the attack of profoundly complex problems in many lines. It is appreciated now that the effective lamp required the services of chemistry, physics, mechanics, the industrial arts and sciences, and only by their progress was it possible to transform the grease cup, which our ancestors thought the last word in lighting, into an efficient illuminating apparatus.

The requirements were as follows:

1. A limpid combustible fluid, abundant and cheap.
2. A designed wick of strong capillarity and free burning without too much carbon residue. The fluid and the wick are thus complementary.
3. Aeration of the flame by controlled draught. The fluid, wick, and draught are mutually complementary.

Since the time was not yet for the production of the ideal fuel, the earlier inventions dealt with the problem of the increased oil supply to the wick by hydrostatic principles. Natural gravity pressure, it has been seen, was employed in north European folk lamps of the seventeenth and eighteenth centuries, perhaps earlier. With the increased oil supply the wick must be designed to burn the fuel furnished, and this introduces proper aeration to prevent smoke. The ancient round wick of yarn produces an excess of unconsumed products in the midst of the flame; woven flat wicks are better. About 1780 tubular wicks furnished complete aeration and the burner was given draught by openings under the flame, a principle long before incorporated in the stove. The draught was brought up through the burner, aerating both sides of the flame and doing away with the center of incombustion. The chimney of Argand added the last essential.

A considerable school of inventors interested in the perfection of the lamp was at work about the period of Argand, and, as is usual in such cases of rapidly focussing inventive thought, it is difficult to definitely place credit for various features. The Swiss engineer Argand, however, is to be given credit for the advanced lamp, his efforts being to perfect the burner and to increase still more the draught by the chimney. Much later artificial or forced draught was applied. The fuel question had not been solved, but the advance of chemistry was bringing out products of possible value. The vegetal and animal oils in use in the early stages of the invention were of heavy body, and various devices utilizing mechanical pressure characterize the lamps at the close of the eighteenth century.

Thelamps of the folk pursued a line of development of their own without regard to the advanced lamps, which were costly and often erratic in behavior. At some period not to be stated the immemorial lamp with wick to edge in a spout was abandoned and the wick was installed in the center of the reservoir. Argand's lamp and many others were based on the ancient model. The central-wick lamp is the ancestor of modern lamps.

The lamps which came in number and variety, many of them very ingenious from the workshops of French and English inventors were articles of luxury, little affecting the slowly developing lighting appliances of the people.[98] George Washington possessed several lamps of the Argand type, perhaps duplicated in few of the great houses of America at the close of the eighteenth century. The popular lamp and the general diffusion of illumination awaited the discovery of a suitable illuminant.

---

[98] It is not intended here to review in detail the history of the lamps of the inventive period.

Illuminating fluids were the object of earnest research carried on by investigators in various European countries and in America. The more important of these put in general use were whale oil, preferably of the sperm whale, *Physeter macrocephalus;* lard oil; paraffin oil made by distilling oil shales, and cannel coal, 1834–1850; camphine, a compound or distillate of turpentine oil over chloride of lime, a dangerous explosive, about 1830, and finally the ideal was reached by the discovery of petroleum in great quantities at Titusville, Pennsylvania in 1859, and the distillation of its chief constituent, known as coal oil, thus solving the problem of nearly a century. The earlier lamps burning heavy oils had one central wick tube without device for raising or lowering the wick. Following Franklin's scientific discovery based on observation of the common lamp, proving that two tubes side by side produced proportionately more light by induced draught, changes to this effect were made in lamps. Three tubes, it was found, produced a contrary effect. On the introduction of camphine tubes were made longer and inclined at a diverging angle. At this period also special burners were devised for burning camphine.

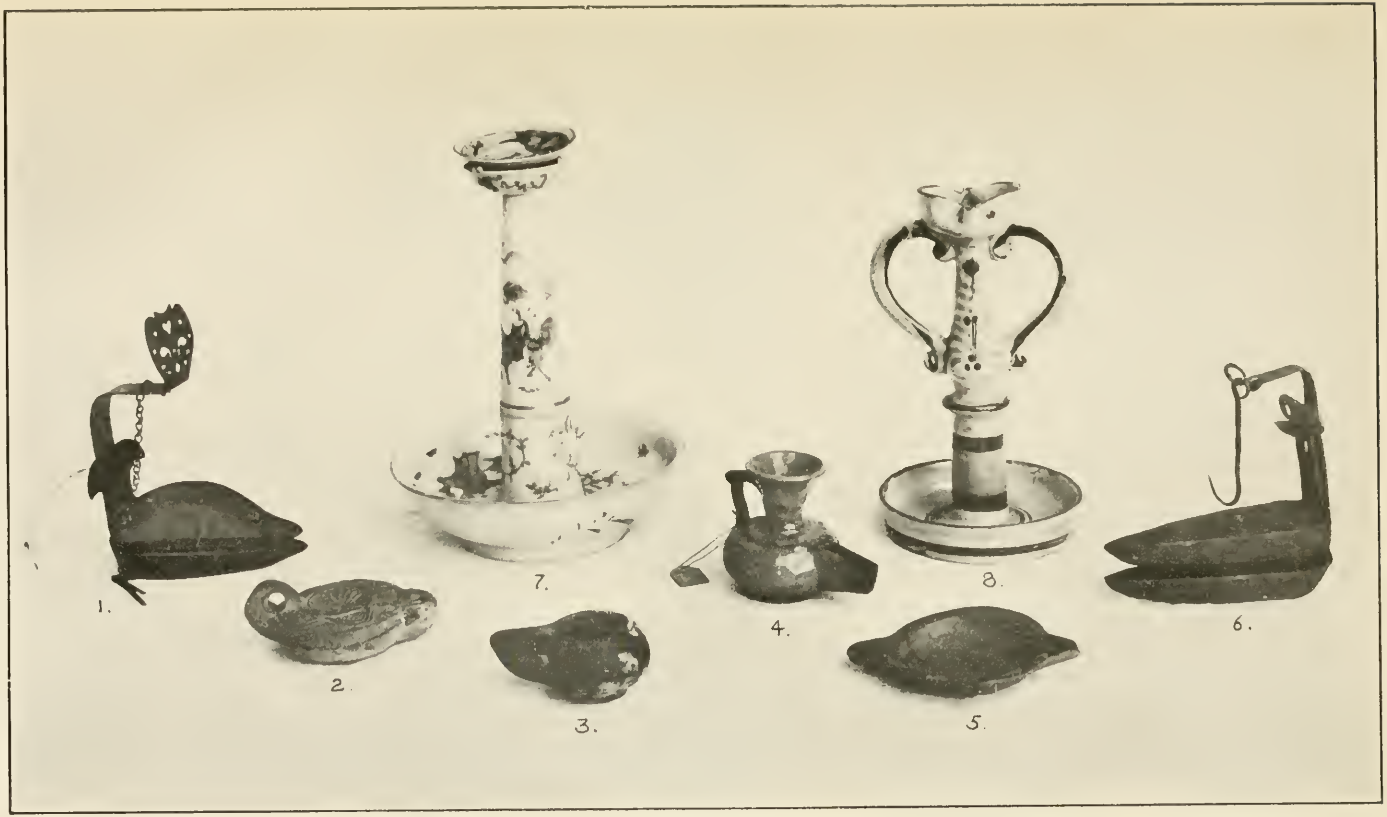
In the sixties in the United States the use of petroleum became general and the common two-tube lamps were mounted with ventilated burners and glass chimneys. These lamps had flat wicks. At the Centennial Exhibition in Philadelphia in 1876 there was exhibited a lamp with tubular woven wick, center ventilated, and with glass tubular chimney having an expanded air chamber at the base. This lamp was the beginning of a line of lamps reaching the highest illuminating results from petroleum (pl. 41, fig. 5).

ETHNOGRAPHY OF THE LAMP

Under this head are discussed lamps which different races have adapted to their needs and which show racial characteristics in art. These lamps belong in the noninventive period, and therefore precede developmentally the lamp of Argand. It is obviously impossible to monograph the lamps of each country treated below. An attempt will be made only to present the characteristic forms coming to notice.

ENGLAND

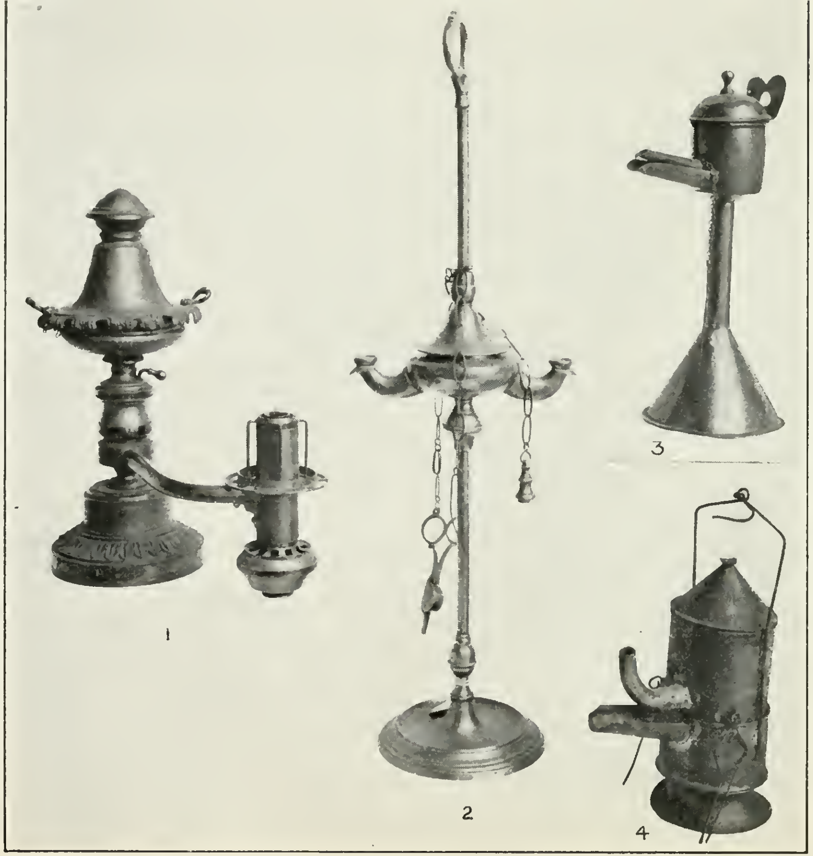
Extemporaneous or local lamps are interesting as devices of the folk, although they have no bearing on the history of illumination. England has many of these which their makers fashioned as an expression of humor or individuality. Thus a block of chalk hollowed out and squared forms a lamp such as it is, or an excavated turnip is made into a temporary oil holder.

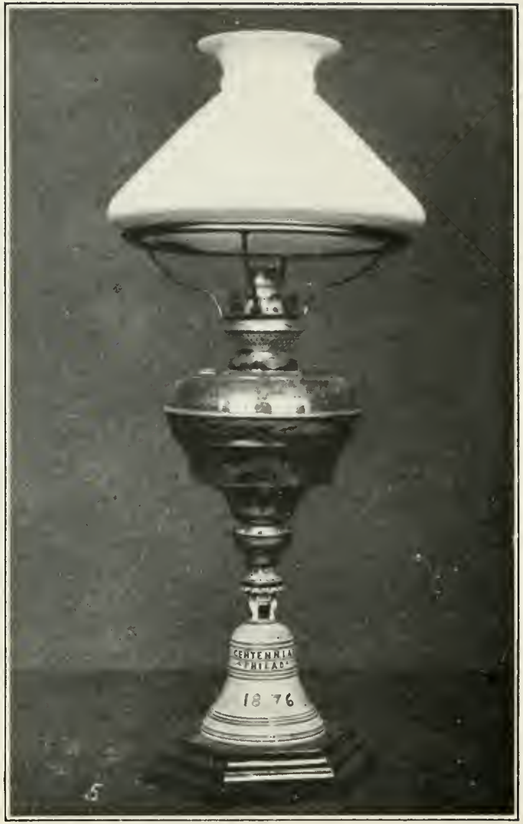


LAMPS SHOWING TYPES OF DEVELOPMENT FROM THE SIMPLER LAMPS

1, Crusie of brass; 2, Ancient Roman pottery lamp; 3, Ancient Roman lamp; 4, Saracenic green glazed lamp, Egypt; 5, Saucer lamp with rudimentary handle, Ceylon; 6, Crusie of iron, Scotland; 7, Simple saucer lamp on stand, China; 8, Majolica lamp with pinched-in saucer, Italy

FOR DESCRIPTION OF PLATE SEE PAGES 219, 220 AND 222





LAMPS OF METAL WITH LIMITED AND COMPLETE GRAVITY PRESSURE

1, Argand type lamp, England; 2, Italian brass lucerna; 3, Dutch brass spout lamp; 4, Kyal lamp, Cape Cod, Massachusetts; 5, Kerosene lamp with tubular wick, 1876, United States

FOR DESCRIPTION OF PLATE SEE PAGES 222 AND 227

In several parts shells were used as natural lamps, an oyster shell at Gower, Wales,[99] and a fusus shell in the Shetlands and Orkneys.

The crusie is a spoon-shaped iron lamp with handle and hook for hanging and a drip catcher, formerly used pretty generally by the folk in England. It is an ancient form of spout lamp much used in north European countries.

A hand lamp shaped like a gravy boat with handle was in use near London years ago. Bakers in Oxford had a cast-iron lamp of this kind for lighting the ovens.[1] The wick was of canvas, and mutton fat was burnt. This lamp appears to have descended from the Anglo-Saxon lamps, which were like the Roman examples of metal or earthenware.[2] Wright also shows mediaeval lamps, cup lamps with knob on the bottom carried on a pole, and men carrying a turnip-shaped lamp (p. 254). Kitchen lamps of a much later period consisted of vessels with an upcurving spout[3] like the Flemish lamps or the Cornish kyal.

Tin lamps of "petticoat" shape, with two tubes for burning fish oil, are illustrated in Crowquill's Baron Munchausen, and belong to the era of the glass and pewter whale-oil lamp which became common in America from colonial times.

Occupational lamps, as the baker's lamp, miner's lamp, etc., were no doubt of a number of varieties in England. One of these from Oxford, through the courtesy of Henry Balfour, consists of a brick with a cup-shaped cavity cut in the broad side, fitted with fat and supplied with a wick. Under occupational lamps of America forms presumably of English derivation are described.

SCOTLAND

Antiquarian interest has long been stimulated in Scotland and Wales, and much data on the phases of home life has been recorded.[4] The oldest as well as the most-developed domestic lamp of Scotland was the crusie. The Scotch crusies are particularly interesting on account of their excellent ironwork and the completeness of this type of lamp. In old Scotland the crusies had become the lamp par excellence, and as typical in form and finish as the lamp of any country Sometimes the crusie was cut from stone, and there has been some conjecture that the original northern crusie was of this material. Crusies were hammered out in a stone matrix by the Scotch smiths. Later domestic lamps begin to show the variations due to exchange of ideas. Spout lamps of tin mounted on a base appear, two-spout bucket lamps, such as were used on ships or in hallways; a tin fountain or gravity lamps, and an improved Argand.[5] The crusie was also adapted for civic uses. There is in the Stirling Museum a crusie street lamp.

---

[99] Archeologia Cambrensis, October, 1895, p. 323.

[1] Information by Henry Balfour.

[2] Thomas Wright. Domestic Manners and Sentiments in England During the Middle Ages, p. 253.

[3] Encyclopædia Brittanica, 8th ed., vol. 13, p. 170.

[4] Northern Notes and Queries, or the Scottish Antiquary. Edinburgh. Handbook of the National Museum of Wales to the Exhibition of Welsh Antiquities, June-October, 1913. Cardiff, 1913.

GERMANY

The domestic lamps in Germany at a former period were similar to those of England. The form of crusie differs in being covered, and the wick is installed in a sloping channel raised above the spout so that the drip drains back into the reservoir. This improvement was probably also found in English crusies. The tin, brass, and pewter lamps involve the same simple principles as in the English forms.[6]

German lamps are found in America, brought over by immigrants.

NORWAY, SWEDEN, AND DENMARK

The lamps of these countries offer a few differences when compared with those of England and Germany, and these mainly in point of folk art

ICELAND

Dr. C. A. Q. Norton is authority for the statement that the Icelanders used a lamp made from a whale's pelvis, the openings stopped with a cement of sand mixed with blood, and also that the lamp was fed with pieces of auk.

"Both in the Faroes and in Iceland stone lamps were used comparatively recently, specimens being occasionally found in digging on the sites of former houses. One thus brought to light in the Westermann Isles is now in the possession of Henry Balfour, who has kindly permitted me to examine it. It consists of a flat volcanic stone, slightly waterworn, on the upper surface of which a shallow depression, roughly wedge shaped in outline, has been scooped out, measuring 4¼ inches in length and 2½ inches in breadth at the base, which is rounded; the apical part of the wedge, which is slightly constricted from the rest at a point 1½ inches from the apex, served, without reaching the edge of the stone, as a channel to hold the wick, which was probably of wool; the stone itself is oval, 5½ inches long, 5 inches in maximum transverse diameter, and 1½ to 1¾ inches in thickness. Judging from a date carved on a horn spoon found with it, this lamp is about 270 years old; its workmanship is superior to that of some more recent Scotch and Arcadian specimens, and also of one I have seen that had been dug up in the Faroes. At first I was inclined to regard the Westermann specimen rather as a mold in which metal lamps were beaten out, but the great depth of the Icelandic brass and iron lamps of the 'crusie' type precludes this idea."[7]

---

[5] D. Bruce Peebles. Northern Notes and Queries, Trans. Roy. Scot. Soc. Arts, vol. 12, 1887, pp. 30, 31.

[6] L. E. Von Benesch. Beleuchtungswesen. Vienna, 1905.

[7] Nelson Annandale. The Survival of Primitive Implements, Materials, and Methods in the Faroes and South Iceland. Journ. Anthrop. Inst., vol. 33, July-December, 1903, p. 250.

Annandale says of the Icelandic use of the bones of the pilot whale (*Globicephalus melas*):

"When fresh they are in use as a fuel for fires over which fish oil is boiled. * * * The jaws were used as a shovel for putting peat on the fire."[8]

FRANCE

The crusie used in mediaeval times in France was without drip catcher. The support was curved forward and provided with notches. A link attached to the base of the hook passed over the notches and allowed the lamp to be tipped forward, so that all the oil could be consumed. This advantage was provided for in some of the Scotch crusies by hanging the inner lamp shell on a notched support.

A crusie of different style, of cast brass, was used in northern France. The reservoir is spoon shaped, with a small opening in the side for pouring in oil. The upper portion is pierced and resembles a dome with columns. It is provided with an iron hook for suspension, and a circular drip catcher hangs below the reservoir. Crusies of iron, some with rigid hooks and others with pivoted hook, as in the English forms, were formerly employed in France.[9]

Among the occupational lamps a remarkable miner's lamp from north France may be mentioned. It consists of a spheroidal reservoir of cast iron with a wick hole near the edge, mounted with a hinge joint for tipping between two wrought-iron arms joined above forming a yoke to which is attached a stout hook. The pivoted cover over the hole for filling is surmounted by the figure of a cock. These lamps are made in the Cevenne and Auvergne districts at St. Etienne, etc. They are used by the potters of Le Puy and by iron miners in Saone and Loire and at Le Mons, Belgium.

Civic lighting in Europe in earlier days was confined to lanterns suspended over the streets on a cord, with cord and pulleys for lowering the lamp for attention, or from brackets fastened to a wall. Many figures of French street lamps are found in d'Allemagne's work cited.

ITALY

Italy, as the center of the best and most widespread illumination of antiquity, presents many interesting lamps reminiscent of the older period or direct survivals and retrogressions. Thus there existed side by side lamps like the lucerna of classic pattern and simple grease dishes of primitive type. Rude iron lamps of boat form suspended by chains from an iron beam were used in the Middle Ages. These lamps approach the crusie form, but had a wick at either end.

---

[8] Journ. Anthrop. Inst., vol. 33, pp. 250-251, pl. 25, p. 9.

[9] Henry-Rènè d'Allemagne. Histoire du Luminaire. Paris, 1891. This is an excellent work, artistically clothed.

The lucerna is a lamp of luxury and ceremony, and it survives in Italy and will survive for these reasons. Lamps of the folk are mostly of glazed and decorated majolica, and often excellent specimens of the art. They consist of a saucer foot, stem, a handle or two handles, and a small bowl pinched up to form a lip or lips for the wick. One of these represents a female figure holding a two-lipped lamp on her head. Another has two gracefully curved handles at the sides of the upright. These lamps do not follow the classic traditions, but are North African. They are of the types found in Mohammedan countries, but much antedate Mohammedanism.

Civic lighting progressed in Italy much as in other European countries in the way of hanging lanterns in the streets. The acme of art in street lighting is seen in the wonderful forged-iron lanterns on the Strozzi palace in Florence. General illuminations were effected as in other parts by little grease pots called *padelle* placed on the façades of buildings.

SPAIN

Lamps of the older period in southern Spain are predominantly of Moorish origin, while those of unconquered Castilla and Leon partook of the phases of art of Spain's European neighbors. There occur in northern Spain forms of the crusie having the drip catcher, the later specimens in use 25 years ago made of tin. A crusie with an upright wick tube was observed in 1892. At that time simple one-tube hand lamps and lanterns were in use among the folk. The peasants also still preserved the open grease lamp. George Borrow saw at San Lucas in 1838 "a small earthen pan on the floor filled with water and oil, on which floated a small piece of card with a lighted wick in the middle, which simple species of lamp is called a 'mariposa.'"[10] This type of lamp is seen in an altar lamp of Sancho IV. It consists of a metal basin like the pan of a balance hung by chains. In the basin is set a glass vessel for holding the oil and water.[11] The elaborate metal-work Spanish altar lamps are installed with this lighting device.

Some of the most remarkable specimens of Moorish art are preserved in Spain. Chief of these is the mosque lamp from the Alhambra. This lamp is composed of four sections, the upper formed of four "apples" in delicate openwork combining the motto of the Al-Ahmares; below is a pyramidal chimney with fine engraved fretwork on each face. The third section is a canopy of four panels finely fretted and engraved with the Al-Ahmares motto in African characters. The fourth is a cylindrical section to which are attached eight fretwork arms. This lamp was ordered by the Sultan Mohammed III of Granada in the year 705 of the Hejira, 1305 A. D. From Granada also is an oil holder in gold of the purest grenadine work of the fourteenth century, bearing enamel inscriptions. An illustration of the mosque lamp is found in Henri Rèné d'Allemagne's Histoire du Luminaire. There is also in the Escorial a beautiful lamp of bronze and coral dating from the seventeenth century.

---

[10] George Borrow. Bible in Spain, p. 289. [11] Museo Español de Antiguedades, Madrid, vol. 1, p. 81.

Moorish lamps encountered in Spain are of terra cotta glazed or unglazed or of bronze. The hand lamp is vase shaped, with handle and the characteristic long spout with open wick gutter. In bronze this form is more elaborate, having a hinged cover on the feeding opening, a pierced handle, and tweezers attached by a chain. Terracotta lamps with three spouts are found, also suspension four-spout lamps of the same material.

HOLLAND AND BELGIUM

The lamps in ordinary use in these countries formerly are characteristic, are well and strongly made, and of good material. The chief departure from the crusie is shown in the number of wick spouts. The Netherlands crusie is provided with a drip catcher. Table lamps with base and stem have long spouts. The reservoir with spout is frequently set in the cup bearing the drip spout. These lamps also have a perforated tab by which they may be hung. Bucket lamps with two spouts or more and with bail for hanging are also found in Holland and Belgium. Their use was for halls and on ships. Note has been made that these lamps have some gravity pressure.

ASIA

The lamps of Asia, both ancient and modern, are of great variety, reflect the highest and crudest art, but so far as invention goes are in the primitive class. Even environmental conditions which, according to theories seeming to apply to Europe, should stimulate inventions for procuring better light in northern latitudes have not produced the predicted result in Asia.

In Arctic Asia little has been recorded as to the use of lamps. So far as may be suggested at present a small circular stone lamp is found, like the dish type found in Alaska, which may confidently be said to be an introduction from Asia. The broad-wick elliptic lamp of the Eskimo apparently belongs exclusively to the Western Hemisphere, but it is used by the Eskimo on the Siberian side. The lamp of the Chukchi and Chuvanes of Siberia is a round dish of stone, but has a small spout formed on the rim where is burnt a small light for smokers, while if a large light or heat are needed the whole dish is used.[12]

---

[12] Information by Gen. James M. Ashton, who traveled in this region in 1924.

NEAR EAST

The common lamp of the Near East, not considering those of Roman and Greek introduction, was a pottery saucer more or less modified by bending the rim to form a trough for the wick. This is true generally for ancient lamps preceding the Mohammedan conquest, and was maintained as the type of the latter civilization. The character of the peoples and their habits of life fixed the simple lamp as the limit of their requirements.

The float lamp has an extended use in the Near East. This use has been promoted by the facility with which glasses for these lamps could be procured. The ordinary float lamp does not require a glass vessel, but hanging lamps, such as are used in mosques, must be fitted with glass tubes. The globular pierced-metal chandeliers,with glass tubes in which the light is installed projecting beneath, are among the most beautiful of light fixtures. Those of vase shape of painted glass are among the rarest specimens of Mohammedan art. Great iron chandeliers of globular shape, with a multitude of arms for holding glass cup lamps, were hung in mosques. The wick was wound on a trifid wire holder which was set in the bottom of the lamp. In Arabia, Persia, and Mesopotamia the lamps of the folk were of the simple type of the noninventive period. One would see in a Persian house at Oroomia, for instance, a saucer of oil in which burnt a piece of string, set in a niche in the wall. Such a lamp made but the dimmest light.

In Mesopotamia lamps have recently been excavated from the ruins of Rhages and other old sites. These lamps are interesting from the standpoint of art, but are classed as simple.

TURKESTAN

Lamps from the Turkestan potteries have been mentioned as of the open-gutter type. They are filled through a bottle neck over the reservoir and have a long beak. Some of them are unglazed, and others, modeled in the shape of animals, are glazed in green and yellow.

The lamp of Bhutum is described as a shoe-shaped pan, with a bit of cotton lighted in the bottom and two or three lumps of tallow laid over it. "The clerk held the paper in one hand and the pen in the other. One man flared the light as close to him as he could, sloping it and shoving in the tallow with his finger as the light grew dim."[13]

Dr. W. L. Abbott procured at Skardu, in Baltistan, triangular soapstone lamps which were in universal use. The wick is drawn to the apex of the triangular excavation and supplied with oil expressed from apricot pips. Doctor Abbott also got pottery lamps from Kashmir. They are saucers of thin terra cotta pressed in on opposite sides to form a handle by which the lamp may be grasped. Another lamp from Srinagar, Kashmir, is napiform of red terra cotta with spout. The wick channel is cut through the rim and the reservoir is open above, as in the Turkestan lamps. This specimen is decorated with incised triangles and the border is scalloped. The native name is *song.*

---

[13] Journal of Thomas Manning to Lhasa, in Narrative of the Mission of George Bogle, etc., p. 220.

INDIA

Some of the common lamps of India were procured by Henry Balfour, of Oxford, from Mirzapur, India. The types are a round, shallow, eathernware saucer with flared sides and the edge pinched into a spout; and an oval earthernware lamp pressed in a form and with sharp spout; and an oval eathernware saucer with flaring sides continued at one end to a sharp spout. Another is a little copper cup having four shallow grooves beaten in the sides for the wicks. In southern India "earthernware saucers with a small peak or notch for securing an oil. wick are used in houses, bazaars temples, etc., usually placed in triangular niches in the walls. The same sort of lamps are found in prehistoric graves. [14]

Sacred lamps are innumerable in India and of infinite variety. In temple lamps ghi or clarified butter, not oil, is burned with wicks of new cotton. If oil is used the til oil only is allowed. One lamp is described as a cup on a foot with a long handle. To the cup is connected a nagas-shaped head on which rest five small oil cups. In another Devi holds five oil cups.[15]

Some temple lamps of brass, with several wick notches around the rim. Others consist of small brass saucers arranged on stands in diminishing circles.[16] In the worship of Kali there are placed on each corner of altar lamps consisting of five earthen pots, four of these surrounding the fifth as the center. The latter is for incense, the others for light.[17] Sacred lamps are often mounted on elaborate metal work stands.

The simple lamp of Ceylon is a shallow saucer of earthenware, with a projection on the edge forming the wick spout and another projection opposite forming a stub handle. Another simple lamp is a shallow elliptic platter of brown composition like cement, neatly made and with a wick spout at one end.

Ceylon brass lamps have multiple wick channels, as those of India described. Others have spouts longer than the lucerna and somewhat resemble Flemish spout lamps. One lamp, probably recent, appears to use gravity pressure on the wick.

---

[14] E. B. Tylor. Journ. Anthr. Inst., vol. 13, 1884, p. 356.

[15] Catalogue of Objects of Indian Art. South Kensington Museum, Tylor Collection, p. 285.

[16] E. B. Tylor. Journ. Anthr. Inst., vol. 13, 1884, p. 356.

[17] Illustrated Catholic Missions, April, 1889. p. 180.

The Burmese common lamp is shallow black clay chatty. This lamp plays an important part in the prettiest of the numerous Burmese feasts, the "Feast of Lights." The feast occurs at the close of Burmese Lent and commemorates the time when Gautama was enlightened. Hundreds of thousands of these little chatties are filled with coconut oil and bits of wick are placed in them. They are then arranged in rows on every veranda, railing, and every place where one can be set. Even the pagodas are outlined and their spirals outlined by the unrivaled whiteness of these little lights. They far excel in beauty the electrical displays of which we are so proud.[18]

In the Shan States the ordinary lamp is a glazed pottery saucer not modified for a wick. They are notched on the edge for ornament, and the foot is usually unglazed.

In Laos a flat vessel or saucer for holding the pork fat or oil, having a bit of cotton wick, furnishes the only artifical light.[19] "The reception room of the prince is brilliantly illuminated with innumerable little coconut-oil lamps."

TIBET

The Tibetan butter lamp is a brass saucer forming part of a stand. It is essentially the simple Chinese common lamp, without a definite place for the wick. Other elaborate metal lamps with wick grooves and evidently of Indian extraction are found in the temples, and many have been brought out of the country in recent years.

CHINA

Mr. Rockhill says: "A few miles beyond Pin Chou we passed through a small village at the foot of a high sandstone cliff, far up in the face of which a number of little temples had been excavated; access is gained to them by ladders hanging down the rock. All around the temples little niches have been cut in the cliff, and in these the people light small lamps so numerous that the whole surface of the rock has become blackened by the smoke.[20]

The lamp in general use in China is a shallow saucer of pottery or metal in which nut or bean or other oil is burnt. The wick is sometimes coiled, as in the candle, and more frequently laid straight. Sometimes the wick is drawn through a hole in the bottom of a tube formed in the bottom of an earthenware saucer. The simple saucer lamp is installed in many ways, in lanterns, on stands, in pierced jars, etc. Mounted on a curious bamboo frame it did service as a street lamp. A lamp consisting of a metal tube on a rod like a sky-rocket is a Chinese illuminating device. Newer lamps, evidently accultural, have long curving spouts, and the opium-smoker's lamp is a central tube lamp like those formerly used in Europe. A form of this was a hanging lamp with shade. Chinese chandeliers are often elaborately incrusted with gilt and kingfisher's feathers.

---

[18] Information by Mrs. U. B. White.

[19] Siam and Laos. Presbyterian Board Philadelphia, 1884, p. 440, 30.

[20] W. W. Rockhill. The Land of the Lamas, New York, 1891, p. 26.

KOREA

In northern Korea a tiny pottery lamp like a saucer with a rough wick dipped in the oil is common.[21] The lamp as usually installed in Korea consists of a rather deep saucer of pottery containing sesamum oil and a cotton wick resting on a stand. The stand has a base and upright, the latter ratcheted. Slipping over the upright is an arm with a lamp rest, and a similar arm below acts as a drip-catcher support. By means of the ratchet the lamp can be tipped or raised or lowered. The specimen described is of wood, but the device is sometimes made of brass. It is called *eh kiung*, lamp stand.

JAPAN

Japanese lighting was complete in all its details and was adequate for every phase of social life. In no country during the noninventive period was there such a varied, artistically satisfying utilization of light. Lamps for burning oil, however, were of the simplest form, a mere shallow dish undifferentiated for the installation of a wick.

The Aino aborigines of Japan possessed a lamp that has every aspect of primitiveness. The reservoir of their lamp is a pecten or clam shell set in the grasp of a three-pronged stick left with the bark on. The wick is twisted bark or pith of rush. Seal oil and fish oil are burnt in this lamp, which is called *nochi beck*. In the absence of a forked stick the end of a stick was split in four parts and the ends separated by wedges. The Aino also had a pothook with ratchet rack after western fashion.

EAST INDIES

Lamps occur sporadically in the East Indies, and so far as may be surmised are not of indigenous culture. In Java spoon-shaped lamps of cast brass, with stand and lamp in one or separate, are evidently of Indian origin. In Nias Modigliani found a rude pottery lamp shaped like a teapot and a similar specimen in brass. These he thinks were imported.[22] A curious lamp was found at Telok Dalam by Dr. W. L. Abbott. It is crusie shape, of wood, and the hook support is mortised through the back of the lamp.

PHILIPPINES

In the southern island of Mindanao brass saucer lamps, usually with standard, are found among the Moros. These lamps seem to refer to India. One of these lamps is a three-spout saucer mounted on a standard. Each spout has a rib across it following the outline of the saucer rim. The Moros also use a small brass pot as a float lamp, which was evidently introduced with Mohammedanism.

---

[21] Carles. Life in Corea, New York, 1888, p. 218.

[22] Un Viaggio a Nias, Milan, 1890, p. 222.

In Luzon hanging lamps consisting of a bamboo frame attached to a bamboo cup on which is set a shallow earthenware saucer are in common use. In the middle of the crossbar of the frame is a hook for hanging the lamp. This lamp is evidently of Chinese origin. A long-spout lamp of terra cotta, well designed and finished, is made in Luzon. Somewhat smaller earthen lamps of this type are used in the odd fishing lanterns by the natives of the coast.

POLYNESIA

Lamps occur rarely among the Polynesian Islands, and it is an open question whether any of the specimens are native. The New Zealand natives used a stone cup lamp like those of Hawaii excavated in broken poi pounders. Concerning Tahiti Admiral Wilkes says: "The lamps, which are always kept burning in their houses at night, are made from the shell of a coconut. The wick is formed of wild cotton and is kept upright in the center of the bowl by two elastic strips of coconut leaf crossing each other at right angles." Wilkes also saw similar lamps in use in Samoa.[23]

Numerous stone lamps have been collected in Hawaii. They are cup shape and hourglass shape, of hard stone. Many are made from broken pestles and some are of wood. The collection of the Bernice Pauahi Bishop Museum at Honolulu has a number of these lamps.[24] A remarkable specimen is figured by Edge-Partington and Charles Heape in their catalogue. It is described as a sorcery lamp of scoriaceous stone used at merais or temples. It is 15 inches high. The base is to represent five joined legs, the body of the lamp is a plain drum, and above is an arched handle with three pits on top. It would seem that the carver worked with the design of some wooden object in mind. If this is really a lamp it is doubtless indigenous. The specimen is in the British Museum.

AMERICA

The ethnography of the lamp in the Western Hemisphere is confined to the Eskimo, who were the only aborigines in this division of the world who possessed a lamp. In the coast fringe from Greenland to the Aleutians there are two types of lamp, the chief being the stone lamp with more or less extended wick edge, and the pottery saucer lamp of the southern Bering Strait area. The first-mentioned type is peculiar in having a wick of powdered moss. The Eskimo lamp has been monographed.[25]

---

[23] Wilkes Expedition, vol. 2, pp. 54, 157.

[24] W. T. Brigham. Catalogue of the Bishop Museum, p. 36.

[25] Walter Hough. The Lamp of the Eskimo, Ann. Rept., U. S. Nat. Mus., 1896; also The Origin and Range of the Eskimo Lamp, Amer. Anthrop., April, 1898, pp. 116–122.

Lamps formerly used by the settlers of America are instances of the introduction of this utensil from various European countries. They serve thus as historical clews and often preserve data which is lacking in the countries of origin. Many specimens were brought from Europe by immigrants and formed the basis for modifications and improvements in America.

In the United States there are many examples of extemporaneous lamps. On the frontier grease lamps were made of a scooped-out turnip in lieu of a saucer, also a sycamore seed ball was found to make a good wick when placed in a dish of fat. An iron spoon bowl, the tang sharpened and driven into an upright, formed a good lamp.

ENGLISH

The English type of iron crusie was early brought to America and was in colonial times in common use. The crusie was an accompaniment of the open fireplace, where its smoke mingled with the smoke of the chimney. The English crusie had discarded the drip catcher for the most part and had become a compact, workmanlike lamp. At one period they evidently were made by a standard for trade, as was the foot warmer. These crusies have a professional appearance.

Tin upright lamps, with one or two tubes in the form of hand or table lamps, were much used from colonial times down to 1830 or thereabouts. Glass and pewter lamps, mainly for the table but often small and duplicated in number for guest lamps at hotels, were common. Frequently these lamps were merely the reservoir of glass with peg base for setting in a candle socket and lighted on special occasions.

DUTCH

Lamps brought to America by the Dutch colonists appear to have left little traces in common usages as to illumination. Such lamps as may have come over are hardly to be distinguished from Belgian specimens.

BELGIAN

Flemish lamps of brass, characterized by a slanting spout and drip catcher mounted on a stem, were formerly somewhat in use in America. Identical specimens, one from Belgium and one from Illinois, arrived at the National Museum the same day.

FRENCH

The principle contribution of lamps from France was during the period of improved lamps using Argand's and other inventions. The older forms, as the open crusie without drip catcher, were formerly used in Louisiana, but few have been preserved. The pavillion-shaped Norman crusie and the north France miner's globular lamp were introduced by immigrants together with other belongings, but had little use in the United States.

GERMAN

German immigrants coming to the United States brought with them their household belongings and set up the domestic life here in accordance with customs of the old country. The weight of conservatism and the settlement in masses in certain localities have caused many usages and customs to persist to the present among the Germans. In eastern Pennsylvania, for example, the crusie called *schmutze* lamp, fat lamp, was in use not long ago, and probably some ultra conservatives still enjoy its antique illumination. The German crusie was usually without drip catcher. It was of iron and of good workmanship. Later crusies of tin became common. Sometimes the crusie was hung on a rack by which it could be raised or lowered, or turned-wood stands or stands of tin were made on which to set the lamp. Two types of Pennsylvania Dutch tin table lamps had common use. One of these consisted of a support set in a pan and a globular reservoir open at the top and having a wick tube in the center. The other had an oblong reservoir with wick tube at one end and a wide flat wick holder at the other. It seems strange that this lamp was patented, the date being February 4, 1851. Spout lamps were not favored.

SPANISH

Subsequent to the Spanish discovery and conquest the devices for illumination current in Spain were brought to America. The indigenous population in some cases adopted the candle, probably because it was a cult object, but the lamp did not assimilate with their habits of life. The simple lamps of saucer and crusie form, such as were first introduced, were retained in Spanish America for centuries. In Yucatan "the darkness of the night is rendered only the more visible by the little earthern vessel, lámpara, with its cotton wick and feeble flame." [26]

In Mexico small lamps of tin with one wick tube are still sold in the markets. Small tin lamps of crusie type are also sold in the tinners' shops.

Peruvian miners wore a crusie in the hat while working in the silver mines of Cerro del Pasco.[27] These were probably introduced from England.

PORTUGUESE

The remark on Spain also applies to the Portuguese possessions in America. Eubank describes a crusie with ratchet tilting device in use in Rio de Janeiro, Brazil. The lamp burnt grease or oil, and every drop of the fuel could be consumed by tilting it forward notch by notch. It was made of copper, with a curved iron supporting rod. Sometimes the lamp was merely a punched-up saucer of copper.[28] The tilting crusie is like one of the old French forms.

---

[26] J. H. McCarthy, Chautauquan, October, 1887, p. 25.

[27] Herndon and Gibbon. Exploration of the Amazon, vol. 1, 1854, p. 113, pls. 19, 20.

There was a lamp called "kyal" used on Cape Cod, Massachusetts, about 1820. It is a quaint affair, consisting of a cylindrical reservoir of tin with conical lid and an upcurving copper spout. The reservoir fits into a cup to the sides of which is attached the bail handle of wire. The name kyal Dr. E. B. Tylor identified as an old Scandinavian name; the lamp, however, is probably Flemish.[29]

AFRICA

The use of lamps in this great continent is almost exclusively confined to the area contiguous to the Mediterranean. In this area are two preponderating groups, namely, Roman and Mohammedan, the latter perpetuating ancient non-Roman types. The modern lamps also show occasionally trans-Mediterranean influence.

MOROCCO

The usual pottery lamp of Morocco is of green glaze ware. It has a basin foot, a stem, a handle, and a bowl pinched into elliptic shape. Larger specimens are elaborate in details, such as the number of lamps and candle sockets, but preserve the general idea.

Metal lamps are generally of the suspended variety. The common lamp is of open crusie type with four beaks or three, and with drip catcher. They are of brass ornamented with repoussé and openwork. The hanging lamp has a basin of cast brass chiseled, suspended by chains to a hanger in shape of a hand. A green glazed pottery bowl forming the reservoir is placed in the basin. In some specimens a bowl having a knob on the bottom is slung in the chains.

The National Museum has a chandelier for the mosque from Tetuan, Morocco. It is of brass strips riveted together in the form of a hexagram, 14 inches in diameter, and with six disk rings riveted in the angles. From the points and rings depend lamp supports consisting of a double bird-shaped flat casting, a boss from which hang three chains brought together to form a pocket in which the lamp of glass or pottery is set. The chandelier is suspended by chains to the frame and attached to a larger boss. From under the boss hangs another lamp support, making a chandelier of 13 lights.

A form of crusie of iron was collected at Fez, Morocco, by Talcott Williams. It is a four-beak lamp secured to a long iron-spiked rod which is thrust into a billet of wood.

A small painted pottery lamp from Algiers has an hourglass shape base, a flattened celumn on which rests a lamp resembling the Roman, and a handle reaching from the back of the lamp to the top of the base.

---

[28] Thomas Eubank. Life in Brazil, New York, 1856, p. 194. [29] Journ. Roy. Inst., vol. 13, 1883, p. 353.

EGYPT

The modern lamp of Egypt consists of a small glass vessel with a tube at the bottom containing a cotton wick twisted around a piece of straw. This appears to be a survival of the common lamp of ancient Egypt depicted in the papyrus of Ani and in wall decorations. Another hand lamp of crusie type, with handle, neck for filling the reservoir, and open wick gutter, is evidently Mohammedan, related to lamps found at Fostat.

Rude lamps were introduced by the Arab traders and slavers into Africa, but were rarely adopted by the uncivilized races. In the Christy collection in the British Museum are lamps of pottery made by the Nupe people of the River Niger.

The Betisemaraka natives of Madagascar possessed an ingenious lamp of iron, thus described by Ellis:

"Around the center of the room was a sort of raised hearth edged round with stones, on which a wood fire was burning. The room was dimly lighted by a lamp of native structure fixed in the sand of the hearth. The lamp itself was a curiosity, consisting of an iron rod 2 or 3 feet long, sharpened to a point at one end and having a cup with a hook above it at the other. The sharp end of the rod was fixed in the sand. The cup contained melted fat. In this was a lighted wick of twisted cotton, and above the flame of the wick a piece of bullock's fat was fixed on the hook, which, as it melted in the flame, replenished the cup below. [30]

FLOAT LAMP

The float lamp is a curious development in illuminating apparatus of ancient origin and widespread use. Examples were found in the tomb of Tut-Ankh-Amen. The wick, instead of being anchored to the side of the lamp reservoir or in a channel, is floated on oil, which in turn is floated on water in a bowl. Necessarily this contrivance gave only a feeble light, and it was used where a limited illumination was needed. Its practical ideas seem to have been to preserve light and to economize light and oil. There may be added also the features of long continuance and safety, the latter provided by the water.

The practical use of the float lamp as a night light was very extensive for sick rooms, and also to keep a light which would enable one to move around or from which a candle could be lit. In colonial times and subsequently in America the float was three pointed, cut by hand from tin or brass, having a hole for the wick in the center and three bits of cork stuck on the points. A great trade in *nachtlichter* originated in Nuremburg, Germany. These were disks of cork fitted with wicks and put up in oval boxes of wood veneer. To this day boxes of night lights may be purchased in Europe.

---

[30] Rev. William Ellis. Three Visits to Madagascar, New York, 1859, p. 134.

The practical use of the float lamp in most countries is correlated with cult, the idea being the preservation of light, its continuance believed to have a magical effect, much as that attributed to perpetual fire. Thus the unsanctified floats of commerce, sometimes called holy crosses, are taken to the proper authorities to recieve a benediction. The use of the float lamps before altars in many countries has been remarked. The Jewish synagogue lamp is a shallow dish containing oil, on the surface of which floated a piece of cork with a wick. The slight light was sufficient to give the course. At Tetuan, Morocco, the float lamp consists of a green glaze pottery saucer hung in a sling of four brass chains depending from a brass disk, which is in turn hung to a flat plate of perforated brass in form of a bird, the design also resembling a hand. In the mosque at Kairwan there hung "between the arches of the roof small and feeble lamps, mere lighted wicks floating on dingy oil in cups of colored glass. From the cupola in the center hung a dilapidated chandelier in which flickered a few miserable candles"[31] (pl. 39, fig. 2).

LAMPS OF ANTIQUITY

It is endeavored here to briefly recapitulate rather incomplete data on ancient lamps and to point out some of the relationships of these illuminating devices to those of subsequent periods.

EGYPT

Traditionally lamps were invented in Egypt, but it is probable that lamps were more generally used in ancient Egypt than in other countries, thus giving rise to the impression. Naturally, on account of the incompleteness of investigations, the methods of lighting in Egypt are little known.

No pictorial representations show the night side of Egyptian life. Dr. James Grant (Bey) in 1890, in answer to an inquiry as to the light which the Egyptians must have required in decorating dark chambers, collected hieroglyphs meaning light, lamps, etc., which he sent to the writer. From these can be distinguished eight forms of lighting apparatus, as follows (fig. 4, *a–h*):

a. In word for white, brilliant. Kind of illuminator not determined, but may be a mass of wax formed on a rod, as the Chinese candle.

b. Same form in word for splendid.

c. Same, with base.

d. Same, with cross marks, in expression to make to shine.

e Principal hieroglyph in a group meaning to penetrate, to inspect, to excite, to make ardent, to make brilliant.

f. A torch, a torch stand, or lamp and torch stand.[32]

---

[31] George N. Curzon. Salvation by Torture at Kairwan, Fortnightly Review.

[32] See Howard Carter and A. C. Mace, The Tomb of Tut-Ankh-Amen, New York, 1923, pl. 75 and p. 164.

"Among the minor articles found in the tomb, none was of greater or more curious interest than the little bronze candlestick, shaped in the form of Ankh, and provided with metal bands for attaching the linen wicks soaked in oil. No such objects have hitherto been found, and while we need not imagine that these small stands were representative of the sole lighting of the Egyptian palaces, they yet give us an idea of the inconveniences which went along with the splendors of life in ancient Egypt, for the light which such devices can have given must have been of the most inefficient and unstable sort."[33]

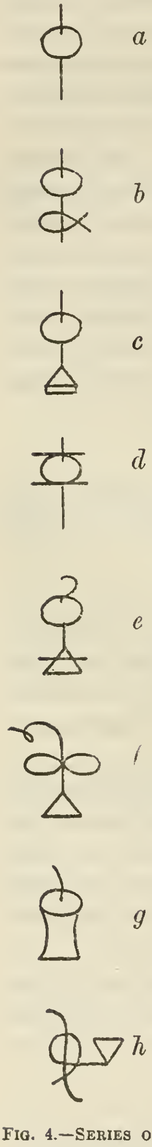


FIG. 4.—SERIES OF EGYPTIAN HIEROGLYPHICS REFERRING TO LIGHT

g. A lamp. The surviving lamp in Egypt, called by the Arabs *kandeel,* consisting of a cup of glass with a glass tube rising from the middle of the bottom. Water is poured in, reaching below the mouth of the tube. Oil is poured in, covering the mouth of the tube. The wick is a stick or straw with a cord of cotton wound around it thrust in the tube. The papyrus of Ani shows such a lamp, the upper part of the flame in red and the lower in white. It is termed "a cult lamp, everlasting lamp put in the funeral chamber by the Egyptians."[34]

h. Meaning a feeble light, apparently a taper held in the hand.

Another form, meaning light, consists of a series of four, like (*a*) connected in circuit at the bases with a line curving back to the third. This may be a portable torch, suggestive to those borne by porters in Cairo years ago.

In view of the great amount of mural work, involving careful and in some cases minute carving, drawing, and application of color in unlighted places, the setting up of tomb furniture and other work underground, it is evident that the Egyptians had adequate artificial lights reasonably free from smoke. On this premise it is not necessary to presume anything like mysterious lost inventions in lighting, as electric bulbs, even if the hieroglyphs suggest them. The hieroglyphs and tomb discoveries reveal a range of lighting apparatus at about 3,500 years ago equal to that of Rome in the best period or that of the time of Louis the Fifteenth. It is affirmed as a reasonable criticism that the lights which the Egyptians developed, certainly the lamp and almost certainly the candle, filled every requirement. The cup lamp like a footlight throwing its illumination upward and aided by reflections from the surface of the oil on water, would be ideal for the wall decorator. The taper, candle, or torch of waxed cords held close to the work would furnish sufficient light. Maspero illustrates an Egyptian bronze crusie (locality not given). The body of the lamp represents a gazelle bound for sacrifice lying on its back in the bowl of the crusie. The crusie has three feet. The support is cylindrical and terminates in a duck's-head hook.[35] Maspero describes this object as a "ladle for dipping wine."

---

[33] James Baikie. The life of the Ancient East, London, 1923, p. 170.

[34] Book of the Dead, Papyrus of Ani. British Museum, London, 1895. See Carter and Mace, p. 164.

Petrie found at Tanis in the house of Bak-akhuin of the Ptolemaic period in Egypt, about 174 A. D., "A bronze lamp, 15 inches high, with a long handle ending in a goose's head, was found lying in the corner of the landing, halfway down the cellar stairs, probably kept there for lighting the way down to the cellar; the spout was wide, as in some terra-cotta lamps, the top is a lid fitting on tight to the body, with a ring on the top, and it has three legs to stand on the ground when not required to be carried or hung up."[36] Petrie writes that nothing from Greece or Italy was found in this house, the only foreign influence being Syrian.

With the entry of the Ptolemaic and Roman periods the characteristic clay lamp becomes common in Egypt. These lamps show little changes in art or form which would indicate that they were adopted by the Egyptians.

In the Moslem period the lighting apparatus became more varied by a number of introductions, some of which remain in use to the present day. These were mainly forms of Persian and other art assimilated by the Mohammedans. Of interest are the punched saucer Arabic-Egyptian lamps recovered at Fostat, near Cairo. Fostat, "Leather Tent," was founded by Amir ebn As in 638 after he burned Egyptian Babylon, where Peter wrote his First Epistle. Fostat was burned in 1168 to prevent it from falling into the hands of the Crusaders. Some of the spout lamps found in the ruins of Fostat have a fine greenish-blue glaze. Lamps found here of the Phenician type are not unlike the style of the metal dish lamps still used by the Arabs.

JEWISH-ASSYRO-BABYLONIA

Lamps found in Palestine date from Roman times and are among the numerous landmarks of Roman denomination. They have no particular characteristics separating them from the Roman terra-cotta lamps except in decoration, which embraces Jewish symbols, as the seven-branch candlestick, shield of David, etc.[37]

---

[35] Gaston Maspero. Egyptian Archeology, New York, 1888, p. 229.

[36] W. M. Flinders Petrie. Tanis. Pt. 1. Egypt Exploration Fund, London, 1889, p. 44.

[37] See H. Hausler. Die Lampe, ihre Bedeutung und Entwicklung in Palestina. Das Heilige Land, pp. 58, 13-22, 79-87, 165-195.

In Assyria and Babylonia, however, are found both Roman lamps and lamps which far antedate the invention of the Roman lamp. These are the lamps in form of a foot with open wick gutter and curved nozzle dating to 1500 B. C. Lamps, one with saucer, column, and formed saucer reservoir, much like the Moorish example, is from Nimrud and Konyunjik palaces and is supposed to date from 880–500 B. C.; the other sets on a pedestal and has a wide-mouth reservoir and spout, comes from the northwest Nimrud palace, and is more like the ancient type. These specimens are in the the British Museum.

ROMAN

The Roman lamp came into general use about 300 B. C. The older forms suggest the long-spouted European crusie with the back support modified into a handle, giving a lamp to be carried in the hand or set. On account of the great number of minor variations in the Roman lamp, series proving any line of development may be laid out. In reality the Roman lamp came into use when social and industrial progress had prepared the way. Pliny is no doubt right in saying that the lamp was not used before because there was not oil, meaning perhaps surplus oil above the food supply. Roman engineers by their mechanical genius vastly improved the primitive oil mills, and in consequence the oil supply was greatly increased.

Roman lamps appear to reflect the work of artisans in metal. This is due to the fact that the lamp models and perhaps molds were made by a class of artists or designers in the minor fine arts called *figuli sigillatores*, who sold them to the lamp makers.[38]

The differentiation of designers and manufactuers is seen rather early in the ceramic art, and it follows up in the Bronze Age when molds were made and objects duplicated.

GREECE

In the ancient period of Greece, as in earlier times elsewhere, lighting was still in the primitive stage and had advanced only to improvements of the torch. Schliemann says:

"Not to speak of candles, even lamps were totally unknown to Homer, and I never found them either at Troy or at Tiryns or Mycenae in the strata of prehistoric house remains. Nay, lamps appear not to have existed at Tiryns or Mycenae before their capture by the Aryins in 468 B. C., because I only found them in the latter place in the débris of the more modern city, and none were found at Tiryns."[39]

Simple saucer lamps are found in the island of Leros, Greece. They consist of a wheel-thrown earthenware with wick channel formed by turning over the sides. A Cyprian lamp of this character is also pinched up to form the wick channel. Lamps of this type are much older than Roman lamps, and the latter appear to have developed from them. No intermediate stages clearly Roman, however, have been observed to make the connection.

---

[38] Isaac H. Hall. Lamps and Oil Vessels, Sunday School Times, Apr. 7, 1886, p. 211.

[39] Henry Schliemann. Mycenae, New York, 1878, p. 50.

In Carthage there have been unearthed clay lamps representing several historical periods, as Phenician, Roman, Vandal, Christian, Byzantine, and Arabic. A collection of ancient lamps is in the Carthage Museum.[40]

Count Byron Khun de Prorok, exploring in Carthage for the French Government, has found many specimens dating from the peoples mentioned above. He concludes that some of the specimens date from 800 B. C. These forms are saucers of clay bent up to form a single wick spout or two wick spouts, and having a long cylindrical handle, as observed in the Cesnola collection in the Metropolitan Museum in New York. Lamps collected by De Prorok have the borders of the saucer bent over on two sides and at the end, luted and two spout holes formed. The spout holes are sometimes formed into two short tubes, the unmodified border of the saucer being used to grasp the lamp in lighting it.[41]

PILE DWELLINGS

Keller figures (pl. 31) a pottery lamp from the pile dwellings of the Ueberlingen See which seems to be locally developed. It is napiform, with small, short spout and a large opening at the apex into the reservoir. It is decorated with horizontal groovings inclosing a band of triangular figures forming a star ray pattern.[42]

In an ancient wreck discovered at Brözen, a village near Danzig, was found "a bronze compass (gimbel or swinging) lamp 4½ inches diameter, 2½ inches high, in form of a flattened bulb, with cylindrical projection downward; a furrow on either side would point toward a handle in which it was sprung. The lamp shows on top an aperture of 1⅞ inches, closed by a lid; three burners within a triangle were placed upon the arc."[43] The description is not clear, and it is undecided whether the object is a taper holder or a lamp. It is an early ship light in which the problem of stability was solved by gimbels and a base weight. No date is given for the find, but the evidence that the ship was buried in sand 1,000 feet from the present shore line indicates considerable antiquity. The specimen is perhaps the earliest boat light discovered.

---

[40] H. Nicolas. Un collection de Lampes Antiques, Rev. Tunisienne, Nos. 64, 65, July, September, 1907.

[41] Descriptions of lamps exhibited by Count de Prorok at the U. S. National Museum in 1924.

[42] Ferdinand Keller. Swiss Lake Dwellings, London, 1878.

[43] George H. Boehmer. Prehistoric Naval Architecture of the North of Europe, Rept. U. S. Nat. Mus., 1891, p. 632. From article by Von M. Bischoff in Leipziger Illustriter Zeitung, Jan. 18, 1873.

Lamps have been found in the Canary Islands in ancient sites. They are rudely cut from lava and sometimes have holes for suspension. The finds of terra-cotta lamps were of one or multiple wicks, and, as Doctor Verneau believes, imported.[44]

ELECTRIC LIGHT

The forms of lighting discussed in this work exhibit in the main a long history and a slow development with a rapid culmination, following in this respect a seeming law of progress. The electric light has no long ancestry, but arises on the threshold of the inventive age and completes its cycle in a short time, passing to the front rank of illumination in a steep curve from its initial point. In the inventive age the old law is abrogated. Its place is taken by a close-knit correlation of ideas by which no invention is for itself alone but is the starting point for some other invention, or its idea is incorporated into some more complex invention. In America the school of invention was the frontier, where men far away from civilization were forced to improvise; that is, to invent.

The uncivilized man does not improvise. His seeming improvisations are only the result of ages of experience and custom, the handling of old, well-worn tools which may be contrasted with the way in which civilized man juggles with his machines, forming their elements into new combinations for predetermined uses. The modern inventor is free from the trammels of an effete civilization and can use his keen mind and native mechanical ingenuity. The American played checkers with his inventions. Superiority over rivals was often a satisfying recompense.

In speaking of the history of the invention of the electric light, it must be premised that it has been difficult to keep pace with the work carried on by investigators in different countries and to assign the dates of important experiments which establish the history. The illuminating quality of the electric spark or flash was a primary observation of all periods, and of no significance until the idea of a continuous discharge was coupled with the idea of its application to illumination. Many investigations were pursued and many inventions preceded the fertile thought, as the machine for producing "frictional" electricity and the Leyden jar and the battery. With these accomplished and furnishing a groundwork for the inventor, Sir Humphry Davy, in 1808, constructed a battery of 2,000 terminal, to the cells of which he attached pieces of charcoal, and when the carbons were brought in apposition a bright spark was produced, and by regulating the distance of the points a continuous discharge gave a brilliant arc of light nearly 4 inches in length. This was an expensive experiment, but it brought out the possible economic attainments of the electric light. The frictional electricity apparatus or electrical machines, the first of which was invented in the seventeenth century, had in them some of the elements which may have led to the dynamo through a great series of discoveries in the first quarter of the nineteenth century. The latter is based upon the experiments of Henry and of Faraday, who produced a dynamo in 1831, and Wheatstone made in 1841 a dynamo which produced a continuous current. With the dynamo, subject to many improvements, the electric light became an economic fact.

---

[44] Revue d'Ethnographie, September–December, 1887, p. 377.

The arc light which had a relatively long development, preceded the incandescent lamp by only a few years. The first use of the latter was in 1862. The arc light was perfected in 1878 by Brush. This light was particularly fitted for larger illumination, and could not be adapted for illumination of small units of space. It can be likened to the great torches which lighted the streets of Rome, while Edison's incandescent lamp, first exhibited in 1879, is like the little Roman pottery lamp bringing light into intimate relationship with the people.

GAS

The history of the economic utilization of gas is quite clear. In 1792 Mr. Murdock experimented on the production of gas from various substances, and lighted his own house with coal gas, and in 1797 lighted the Soho manufactory at Birmingham with the same fuel. The Lyceum Theater, London, and a cotton factory at Manchester, were lighted in 1803.[45]

From these early installations there was a rapid progress to lighting streets in cities, Pall Mall, London, in 1807, being the first. Gas was introduced in the United States at Baltimore in 1821, at Boston in 1822, and in New York in 1827. Natural gas, which issues from the earth in many places, was used in China for a long time. Klaproth speaks of the use of natural gas conducted in bamboo tubes for burning in the city of Khiung-tsken.[46]

The most noted gas emanations are at Baku, which have been known for a long period (see Fire Worship). So far as is known the natural gas at Baku and other localities around the Caspian has never been used for practical purposes.

CIVIC LIGHTING

The lighting of cities, which was formerly hardly regarded as a civic need, has become the chief feature of the industrial science of illumination. Before the fifteenth century it appears that the streets of cities at night were dark and that lanterns and torches were carried by those who used the streets at such hours.

---

[45] Progressive Age and Water Gas Journal, Philadelphia, 1888, p. 61.

[46] Asie Centrale. Also Humboldt, vo 3, l.Paris, 1843, pp. 519-530. For Japan see Griffis, Mikado's Empire, p. 21.

In Amsterdam horn lanterns on posts were street lights in 1699. In Paris fallots or vessels burning pitch, resin, or other combustibles were street lights in 1588.

"No general system of lighting was inaugurated in Venice till 1719, when the Merceria had lamps put on it. In 1720 lighting was extended to the whole city. Before this, in 1450, a few lamps were kindled under the arcades for part of the night. In 1128 the only light on the streets was an infrequent shrine lamp.[47]

In London in the early fifteenth century, by edict of Henry V, householders were required to hang out a lantern during the dark of the moon for the period between Michelmas and Lady Day until 11 o'clock at night. After 1736 oil lamps were installed in place of the horn "lanthorn" and this marks the taking up of the work by the city.

Generally in the first stages of civic lighting such illumination as was furnished was due to individual effort and expense and to the need of identification of inns and other enterprises whose business was extended into the night. Later some beginning system was adopted which led to public lighting. The beginning of engineering requirements for civic lighting is seen in the use of gas. The growth and complexity of this feature have become enormous.

ILLUMINANTS

The lamp is usually treated as an object of material culture and described as to its locality, material, form, art, and period. It has not been considered in relation to the illuminants for which it was devised and which kept it for ages a simple contrivance furnishing a meager light. The history of the exploitation of illuminants for the lamp, were it written, would yield to no other subject in variety, color, and also economic interest.

The materials suitable for burning in lamps would be classed as natural, crude, refined, and artificial, and be of mineral, animal, and vegetal origin.

MINERAL

There is more historical data on mineral lamp fluids than on any other class. Native naphtha was used from an early period in Persia. This mineral oil issues on the eastern and western shores of the Caspian Sea and has been known for ages. In the thirteenth century Marco Polo speaks of it and its use for burning by neighboring nations. The Baku region was the center of the fire worship of the Magi (see Fire Worship). In the life of Alexander, Plutarch states that fire issues in a continuous stream at Ecbatana in Persia, and he also discourses on the uses and properties of naphtha.[48]

---

[47] Thomas Okey. The Old Venetian Palaces, London, 1907, p. 259.

[48] Plutarch's Lives, vol. 2, pp. 494–496.

In Japan and Burma outcrops of mineral oil were put to some use for burning, but probably at no distant date. There are many instances of the use of the limited supply of outcrop mineral oil long antedating the production of enormous quantities of kerosene, which began about 65 years ago.

ANIMAL

Most of the lamp fuels under this class are derived from water animals, the fats of land animals being unsuitable on account of their fixity, which is shown by the content of stearin and other bases compared with the oil. Oil from aquatic animals, containing a smaller amount of separable bases remains fluid in cold climates and the fats are more easily reduced to a liquid state by the heat of the lamp flame. In many respects fish oil is comparable to petroleum.

In view of these facts the animal lamp fuel was confined to oils derived from water animals, principally from sea life, and thus was collected on the coasts. Fish oil was the earliest animal oil secured in amount. In the island of Skye the oil burned in crusies was extracted from the livers of fish. The livers were allowed to semi-decay and were then heated and the oil poured off into a stone jar or craggan. The oil made in this way was dark, but thin and good.[49]

Seal oil was used in preference by the aboriginal coast dwellers of the north. The Eskimo and Aino are examples. The lesser water mammals were more easily taken than the whale, and there is a priority of the use of oil derived from them. Fish oil was also used before whale oil. In response to a demand for a better supply of oil among other economic products derived from cetaceans, whaling increased rapidly to a great industry, threatening to exterminate these great sea animals. It has been observed that the introduction of petroleum and the consequent decline of the industry prevented the extinction of the whale. Improved technical methods early in the nineteenth century also placed lard oil and other animal oil at the disposal of those who burned lamps.

In the height of the sea-oil industry many oils for certain uses were procured from numerous sea animals. Of those for illuminating purposes were fish oil, seal oil, and whale oil. Whale oil was classed as from different species of whales and known as crude, natural winter, bleached, extra bleached, refined, and whale-oil "foots." The sperm oil, which was regarded as superior to any other whale oil, was known as crude sperm, crude head sperm, crude body sperm, natural winter sperm, and bleached winter sperm. Grampus, blackfish, and porpoise oils from these cetaceans were sold as crude and refined. Seal oils were marketed as natural and steam refined. Menhaden oil was the most abundant fish oil, and was sold as natural, pressed, and bleached.

---

[49] Proc. Soc. Antiq., Scotland, vol. 2, 1880, p. 145.

VEGETAL

Abundance of oil is derived from the vegetable kingdom, much of it excellent for burning in lamps. Many of the kinds of vegetal oil for lamps were limited in amount and used locally, and some, as palm, olive, and sesamum oil, were the basis of important industries. The extraction of vegetal oil in most cases is difficult and requires mechanical appliances, therefore it would be anticipated that progress in this work would not register until the agricultural period. Many species of the palm, however, furnish fruits and nuts containing oil which is capable of extraction by crude aboriginal methods. In the environment of the palms, however, there was a limited demand for illuminants, and the use of palm oil for the purpose is observed principally in southeastern Asia. In Siam coconut oil and in India palm oil was used for burning.

An important source in the East was the Dipterocarpus, or oil tree. The nuts of the *Aleurites triloba,* burned as a torch in the Polynesian islands, were made to yield lamp oil in India. In Brazil various palms yielded oil for cooking and illuminating purposes. Among these may be named *Denocarpus bacaba, D. patana, Caryoca braziliensis,* and *Euterpe edulis.*

Oil from the castor bean was used as an illuminant in many localities. The streets of Lima, Peru, were lighted with it in 1879.

Nut oils were good for burning in lamps. In Cashmere, India, walnut oil and oil expressed from apricot seeds were used in lamps. Hickory-nut oil was so used locally in the United States. Beechnuts, brazil nuts, pistachio nuts, canarium nuts, candlenuts, physic nuts, are among the nut sources of lamp oil.

It was early recognized by the Romans that from the small oily seeds of various plants, especially the sesamum, a valuable product could be secured. In modern times rapeseed and poppy-seed oil was consumed in lamps in Paris, and much of the rapeseed oil was used in the lighthouses of Europe. In the United States it was employed in lighthouses about 1854 on account of the increasing price of sperm oil.[50]

The stones of the grape yield good lamp oil, which was used in Italy before 1850. In the Italian Piedmont walnut oil was burned in lamps in the period before kerosene.

Olive oil formed the basis of one of the greatest developments in the history of illumination, marked by the diffusion in the Mediterranean of the Roman lamp and its common and extensive use for light. In the earlier period of the Roman lamp we have the suggestion of Pliny mentioned that lamps could not be used extensively because of the lack of oils to burn in them. Shortly, however, Roman engineering and agricultural skill applied to the fields and the ancient olive mills and presses furnished an adequate supply for food and light. Numerous examples of early mills and presses have been uncovered in the Mediterranean area and have been well described by MM. Clastrier, Guebhard, and Goby.[51] These mills and presses were suitable for the expression of oil. not only from olives, for which they were probably chiefly used, but for oily seeds of various kinds.

---

[50] Joseph Henry. Smithsonian Report, 1880, p. 483.

In Syria at the present time olives are crushed between two large stones turned around by a pole. Warm water is poured over the mass, the oil rises to the top, the woman takes large double handful and with a skillful motion transfers it to a strainer by her side.[52]

For further notes on illuminants see Ethnography of the Lamp.

LIGHT IN CULT

Parallel with the fire cult a great body of cult has grown up around light. Subtracted from the fire, supplied with sustenance and requiring a different form of attention, the light becomes a thing apart and takes up a round of inventions which have not culminated at this day.

The eternal contest of light and darkness has been an age-long experience to mankind. Out of this declaration of nature has evolved the worship of fire as light, and at length the philosophy of Zoroaster pitting light and darkness as antagonistic elements named good and evil.

At some period also comparatively late in man's history the sun as the greatest natural source of light comes to be worshipped and a vastly ramifying cult is established. Below these cults, which represent elaborate philosophies, are the observances of the folk, many of them perhaps inheritances from more ancient times or normal growths in indigenous religious ideas. Some instances of these customs maybe given and the frequent parallelism with fire customs noted. In some cases it is difficult to separate the ideas of light and fire, but in most cases there is a clear differentiation, as in early times there could easily have been knowledge of the two functions of fire. It has even been conjectured that the primary usefulness of fire was for the light-giving quality, a theory which has much weight.

There was considerable advance in reasoning before the sun and fire were correlated, and there was never a generalization on the connection of the light of the stars, moon, and other natural luminous phenomena before the advent of exact science. It appears, therefore, that light was formerly inseparable from fire, and that with the advance of artificial illumination an increasing differentiation has developed in cult practices dealing with fire and light.

---

[51] Presses et Moulins a Huile Primitifs, Bull. Soc. Prehist. de France, January, 1910, pp. 1-16.

[52] Woman's Work for Woman, January, 1888, p. 16.

The torch, candle, and lamp as vehicles of light are prominent in the cult of light.

CUSTOMS CONNECTED WITH THE TORCH AND CANDLE

Numerous customs surround the torch as a symbol and as an accompaniment of ceremonies. The Loango peoples sent out a lighted torch to denote war. In the Congo a dispute between two men was decided by wager of battle. A torch was lighted and the battle continued till it burnt out. [53]

LUCERNA

Small lucerna are used in mortuary customs in Italy. They are placed at the head and foot of the corpse instead of candles. (Information by D. I. Bushnell, jr.) It appears that this ancient form of lamp has survived into the present on account of this custom. All funerals were formerly by night.

THE TORCH AND CANDLE IN FUNERAL RITES

It is observed that light is a very common feature of funeral rites, and this use is found in every stage of culture. The reasons given may be many and varied, but the proximate explanation of the custom is that light is used in funeral rites as it is under ordinary circumstances for the purpose of illumination for those who have gone to another sphere of being. In this sense the light is regarded as having the magic power to penetrate the veil of death.

At the funeral of royal personages in Hawaii large torches made of a number of coconut-leaf midribs strung with kernels of the *kukui* or candlenut were placed before the corpse. The midribs were massed in form of a *kapili* or standard and stood about 5 feet high from a bamboo base.

The Eskimo at St. Michael and on the lower Yukon hold a feast of the dead in which lamps are used. At the feast each one in honor of dead friends takes a lamp into the kashim. The lamps, arranged around the room a yard from the wall on supports about 2 feet high are kept burning till the feast is over. The main lamp is in the middle of the room. The celebrants sing and drum before the chief lamp. [54]

In the great feast to the dead at Razbinsky, lower Yukon, Alaska, on the third day 12 lamps are placed at regular intervals around the room. These are clay lamps set on wooden posts or wicker-top holders. The customary kashim lamp burns at the back of the room. The lamps are filled with seal oil and burn throughout the feast. They are supposed to light the dead on their way. Offerings of fish are thrown on the floor before the lamps.[55]

---

[53] Freiderich Ratzel. History of Mankind, London, 1896, vol. 3, p. 129.

[54] E. W. Nelson. The Eskimo About Bering Strait, 18th Ann. Rept., Bur. Amer. Ethnol., 1889, p. 364.

[55] Idem, pp. 365-379.

The Jews had a custom of placing a lighted wax candle in a pot of ashes by the corpse.[56]

For a month after the death of a parent a light is kept burning, and at the anniversary of the death a lamp is lighted for a day. This is believed to signalize a belief in the immortality of the soul. The lamp used is the primitive one of the bowl with oil floating on water and a float carrying a wick.[57]

The Russians of St. Petersburg carry lighted lamps before the dead in funeral processions, and it is said that these lamps help the soul on its upward journey.[58] The poorer classes, however, do not carry lamps.

The Egyptians place candles beside the dead.[59] This is only one instance of a world-wide custom of lighting the dead.

The candle as a cult object features in all the religions of the world, and, as has been pointed out, the perpetuation of this superseded illuminating device is on account of its use for ceremonial purposes. The phases of its use are numerous. It is first set apart as an object possessing a certain sacredness by rites called blessings or rendering sacred, which fundamentally are for the purpose of producing the requisite psychological reaction on the part of the devout. This consecration is a necessary and legitimate method of producing a religious attitude, and is observed in the crudest manifestations of religious sentiment in the lowest observed stages of culture.

The candle, having been blessed, is put to the various uses developed in cult practices, some of which have been mentioned. In the church it serves not only for illumination, but to convey some messages to the spiritual world or by its light to conserve the well-being of the people. It is lighted during thunderstorms to ward off lightning, it keeps off sickness from man and animals, its beams drive away evil spirits, thieves, and other dangers. It serves as a simple means of relieving the mind of harmful stresses.

In China white candles are used in worship by gamblers in gambling houses, while red candles are required in religious ceremonies.[60]

In Cambodia little wax candles are employed in ancestral worship before the altars. In India candles are used in Buddhist worship, and offerings of money are sometimes stuck in candles and placed before the altars. A curious instance of light magic comes from Greece, where a candle in a pumpkin lantern was let down on the sea by Greek mariners to dispel fog.[61]

---

[56] Thomas Brown. Hydriotaphia, Works, London, 1892, p. 421.

[57] Information by Dr. Cyrus Adler.

[58] The Outlook, New York, vol. 79, Mar. 18, 1905, p. 681.

[59] Georg Ebers. Aegypten, New York, 1880.

[60] Information by Stewart Culin.

[61] Penny Magazine, 1832, p. 53.

Thomas Eubank describes the Brazilian Catholic rites of consecrating water and the use of holy water in the consecration of fire at Easter. "The *cirio*, or 'Great Paschal Candle,' a very large and elaborately ornamented one, is the principal object in this ceremony. * * * The custom is to have three *triune* candles, each consisting of three tapers longitudinally united, to represent the unity of the Godhead in a trinity of persons. One is placed near the entrance, another halfway to, and the third at the altar. They are lit, and all others carefully extinguished. The priest takes the *cirio* and with the usual ceremonies baptizes it at the font. He drops chrism and baptismal oil from vials on the water; breathes three times over it, not crosswise now, but as if forming with his breath the letter Y. He dips the lower end of the *cirio* a little in, raises it, and plunges it farther down, a third time, and it reaches the bottom of the font. Each movement is accompanied with similar expressions to those used in sanctifying the water. It is now lit at one of the triune tapers and placed by the side of the high altar, when the other lights are kindled at its flame."[62]

The Hopi Indians include light as a component of their *naquapi*, or ceremonial medicine, which is a liquid. This is done by reflecting the light of the sun from the facet of a quartz crystal into the bowl containing the liquid.

LAMPS USED IN CULT

Dr. I. M. Casanowicz describes a lamp in the National Museum used by the German Jews in their houses. It was lit on the eve of the Sabbath. The specimen was made in the eighteenth century at Fellheim, Germany. The lighting of a lamp is the sign of the commencement of the Sabbath. Lights are neither lit nor put out on that day. In describing the function of a silver spice box manufactured in Lampheim, Germany, about 1740, he says:

"This box, filled with spices, is used in the Jewish service known as *Habdalah* (or separation), the service of the conclusion of the Sabbath. There is a tradition that at the beginning of the Sabbath a special angel accompanies the worshipper from the synagogue; this angel remains with him until the conclusion of the Sabbath. The departure of the angel leaves the man faint, and the spices are intended to restore him. The objects used in this service are a cup of wine, the spice box, and a candle. First a blessing is said over the wine, next over the spices, and last over the light. The candle is then extinguished by having wine poured upon it."

Of especial interest is the cult lamp called *hanuka* used at the Jewish feast of Hanuka or dedication. Doctor Casanowicz says that: "The feast of dedication is held in remembrance of the rededication of the temple of Jerusalem after its defilement by Antiochus

---

[62] Harper's New Monthly Magazine, vol. 7, November, 1853, p. 737.

Epiphanes, 169 B. C. Josephus records that it was a feast of lights. It is celebrated eight days. On the first night one light is lit, on the second two, etc. The lamp is probably of Dutch make and exhibits an interesting survival of the ancient Roman lamp."

The usual hauka lamp has spoon-shaped oil containers, eight in number, in a row, and one isolated lamp above called shammas, or servant, from which the other wicks are lighted. This arrangement is invariable, but the hanuka is quite varied as to art, country, and period. The form with oil lamps is not ancient, the Russian hanuka with candles being more in accord with the methods of lighting in Biblical times. The relation of the hanuka in ceremony with the ancient widely disseminated feast of lights is mentioned by Josephus.

The Hindu lamps with multiple lights may point to relationship if not origin in respect to the hanuka. A figure of a god from India, figured in the New York Herald, April 2, 1905, bears 43 spoon-shaped lamps placed on various parts of the body, and, as remarked, there are many examples of multiple lights among Hindu sacred lamps.

FEAST OF LIGHTS

Celebrations in which light is a prominent feature are without number. At first rudimentary, they occur in every phase of man's culture. The idea of light as well as fire appears to be inherent in the primitive bonfires. The stimulus to joy in firelight has a profound basis in human nature.

Concerning feasts of lights, Pere Lafitau says: "Since most of the feasts of the savages were celebrated during the night and those who engage in them went through the villages and into the cabin carrying firebrands in their hands or torches of birch bark, I have some idea that this may have been the origin of the lymphatic races, which were made in honor of Bacchus, Pan, Ceres, of Vulcan, Prometheus, Minerva, etc., and which were called the feast of torches or of lamps, of which we have found many vestiges in the ancient monuments and in the authors that have spoken of it under different names who place their origin so far back that they attribute them to the gods themselves or perhaps to primitive man. The most celebrated of these feasts was the Panathenees at Athens, in honor of Minerva; the Lupercalia at Rome, in honor of Pan; and the feast of lamps in Egypt, in memory of Isis. I do not doubt that the feast of lanterns is held with such pomp among the Chinese and of which we have so good a description in the Memoires of Pere du Comte."[63]

The Japanese festival of the dead, "feast of lanterns," called Bom-matsuri or Bonku, is held from the 13th to the 15th of July. Many places hold two such festivals. "At sunset pine torches, fixed in the ground before each house, are kindled to guide the spirit visitors. Sometimes, also, on the first evening of the Bommatsuri, welcome fires (mukaebi) are lighted along the shore of the sea or lake or river by which the village or city is situated; neither more nor less than 108 fires, this number having some mystic signification in the philosophy of Buddhism. And charming lanterns are suspended each night at the entrance of homes—the lanterns of the festival of the dead—lanterns of special forms and colors, beautifully painted with suggestions of landscapes and shapes of flowers, and always decorated with a pecular fringe of paper streamers.[64]

---

[63] Moeurs, vol. 1, Paris, 1724, pp. 369–370.

In China the festivities which culminate in the feast of lights begin on the 13th of the first month. On that day is *lung-hung-tui*, or procession of the great dragon. Paper dragon lanterns of great size are carried in the procession. On the 15th is feast of lanterns, which consists of lighting up houses and every available thing with paper lanterns. This feast is interesting, as it is a form of the ceremony found all over the world and brings the question of the origin of customs by contact or outgrowth very strikingly forward for consideration. On the 15th day of first moon is held a feast of lamps in Tibet. The lamps are lit, and by the way they burn, if the flame burns clear and strong there will be a good season, and contrariwise if they burn dim.[65]

In India the feast called *divali*, the feast of lights, lasts three days, as in China and Japan. Previous to the feast people assiduously clean their houses in anticipation of the visit of a goddess who penalizes those whose houses are untiy. On the day of her visit the houses inside and out are decorated with little saucer lamps filled with oil and having cotton wicks. Firecrackers and other fireworks are shot off. During the ceremony a particular kind of confectioney in shape of elephants, horses, monkeys, men, temples, and so forth, is sold.

SPIRIT OR EXPIATORY LIGHTS

On the 30th day of the seventh month the Chinese set little lamps floating down the rivers. They have a belief that on this night and day the spirits of the dead are set free from their Tartarean limbos and visit their old accustomed haunts. The lights are for their benefit. Food is also placed for them. The lamps are made of two cross sticks as floaters, with a little cup of paper containing the grease. Compare this with the French *Jour des morts*, All Souls Day. In Tibet also on the 15th day of the first moon lamps are floated down the river for souls.[65]

---

[64] Lafcadio Hearn. Unfamiliar Japan, New York, 1894, vol. 1, p. 1078.

[65] Information by W. W. Rockhill.

In Siam, as an expiation, a model of a Chinese junk, gaily painted and with wax tapers, fruit, and flowers, is launched at dusk with tapers lighted. The junk has clay figures of men as a crew and is sent out during cholera epidemics.[66]

The Malay women of Panjwan Sokmaviro, Borneo, prepare a lamp made of half a coconut shell filled with oil, with a cane wick, and float it down the river as a charm to keep their husbands safe while gutta collecting.[67]

PERPETUAL LIGHTS

The perpetuation of fire as a fetish serving by its continuance to keep unbroken the chain of benefits has been mentioned. The same phenomenon is observed in regard to light. Perpetual lights are sometimes mere folk observances, but are generally connected with some organization kept up over long periods. "Ever-burning lamps," referred to by Shakespeare, were maintained in English chapels, and the one in Townley Chapel is said to have been kept alight for 1,000 years.

The Jewish *ner tamid,* perpetual light, hung in front of the ark containing the scrolls of the law in the synagogue. It is thought that this was a floating wick lamp. Altar lamps of the Catholic church are of this class, and the idea of perpetuation is inherent in the function of this lamp.

Connected with the perpetual lamp is a great body of myth and pseudo science referring to lamps which would burn perpetually without replenishment. Earnest search was made by alchemists and more modern chemists for such a desireable illuminant. Stories were invented as to the finding of such lamps in tombs, attributing to the ancients the command of this mysterious lamp fuel. In one of the oldest historical works of China, by Ssu-ma-chien, the name is Ssu-chi, mention is made of candles which were made of the "man fish" and put in the tomb of She Huang-ti of the Chin dynasty, about 200 A. D., in order that the candles might burn forever.[68]

MYTHS OF THE ORIGIN OF LIGHT

Myths of this content are rare compared with the number ot myths of the origin of fire.

Among the Mohave Indians of Arizona the culture hero, Mastambo, made light.[69]

One of the fundamental elements of the mythology of the Mewan Indians of California is the existence at a great distance of a primordial heat and light-giving substance indifferently called fire, sun, or morning, for in the early myths these were considered identical or at least interconvertible.[70]

---

[66] Siam and Laos, Presbyterian Board, Philadelphia, 1884, p. 243.

[67] Carl Bock. Head Hunters of Borneo, London, 1881, p. 48.

[68] Information by W. W. Rockhill.

[69] A. L. Kroeber. The Mojave Indians, Amer. Anthrop., new ser., vol. 4, 1902, p. 283.

The Haida Indians of British Columbia also had a myth on the origin of light.[71]

LIGHT GODS

Light is one of the attributes of many gods. It is penetrating, intangible, shines far off, and is not harmful, but on the contrary beneficent, so that its attribution points to a higher phase of culture. While in a sense fire gods are also light gods, it is difficult to select from the innumerable spiritual beings a light god. The Assyrian god Ao or Bin seems to be of this order. He is regarded as the divine light, the intelligence penetrating, directing, and vivifying the universe. One form of Ao represents him as god of the atmosphere or firmament. In this Ao relates to Indra, the Hindu god of the atmosphere.

The closing chapter appears to require only the final word to complete the record of the phase of free energy which extends from the beginning so far as man is concerned to now. To draw forth frictional heat sufficient to ignite his wood dust savage man put forth all the physical strength he possessed; to unlock the new energy enlightened man must attack the atom with voltage of millions, grinding it out by superfriction foreshadowed by the savage. Thus the old will pass and become a matter of curious interest to the philosophic mind.

---

[70] C. Hart Merriam. The Dawn of the World, Cleveland, 1910, p. 18.

[71] Geological Survey of Canada. Progress Rept., 1880, p. 151.

INDEX

Page
Abbott, W. L 220, 230, 233
  observations on rice steaming 43
  stoves collected by 17
Abdominal warming devices 16
Abenaki Indians addicted to pyromancy 182
  torches of 201
Aboriginal ovens 34
Aeration of fire 22
Africa, lamp of 237
  primitive valve bellows from 24
  stoves 48,51
  torches 206
  West, torches 206
Agriculture and clearing 65
Aino, birch-bark torches of 206
  goddess of fire 127
  shell lamp of 219, 233
  Yezo, fire drill 89
Air holes, side draught 23
  compression 24
A-Kamba tribe, myth of 164
Akikuyu, East Africa, fire drill 94
Alarms, fire, and prevention 82
Alaska, location of fireplace in 9
Aleuts, ancient rude lamps of 218
  pottery lamp of 234
  stone lamp of 234
Algeria, pottery stoves from 45
Algonkian Indians, addicted to pyromancy 182
  torches of 201
Almaciga gum torches 208
Altars 132
  Nahuas, Mexico 132
Amadou, slow match 4
Ambulant stove, or scaldino 16
America, lamp of 234
American Indian tongs 19
Ammonites, fire practices of 178
Ancient fire art, traces of xii
  fireplaces xii 8–14
  lamps 219, 239
  torches 199
Andamans, fire preservation by 3
Anderson, Hans Christian 167
Andiron, perpetuation of primitive 20
  primitive 12
  stone 9
Andree, R., on metallurgy 75
Anglo-Saxon fire burial 168
Animals, fat of, in candle making 211
  lamp fuels derived from 247
  utilization of warmth of 1
Anthropological Society of Bombay, journal of 172

Page
Apache Indians, fire signals of 59
  lightning taboo 145
  Yumas, fire customs 100
Appliances for special heating uses 14
Application of draught 22
  of fire xi
  of fire to bodily wants, chart of 15
Apricot pips, lamp oil from 230
Arab traders, lamp of 238
Araucanian Indians, Chile, method 103
Arc light 245
Archeological research, fire in 58
Architecture, fire in 13
Arctic Asia, lamp of 229
Argand lamp chimney 223
  type lamps, England 224
Arizona, earthquake in, cause of ignition 6
Artifactural myths 159
Artificial light as factor in aiding expression of ideas through speech 190
Artificial means of fire making 84
Aryan fire-origin myth 161
Ashes, cremation, pottery vases for 170
  extract of alkali 72
  of bone used in tanning 72
Ashmolean museum, Oxford 15
Ashton, James M., observations of 2
Asia, air bellows of Tibet 24
  lamp of 229
Assiniboine, origin of name 41
Assyria, ancient lamp of 242
Atkins, Q. F.. Wyandot Indians 133
Atlantic coast, conch-shell lamp of 219
Attassee Indians, Alabama, time measure 83
Auk, used as fuel 57
Australia, bark and grass torches of 208
Babylonia, ancient lamps of 242
Backlog 18
Bake oven, European and introduced 40
Baker, Sir Samuel, fire hunting in Central Africa 63
Baking, animal in skin, Australians 34
  Mexico 39
  — primitive devices 32, 34
  slabs of pottery and stone 32, 40
  without oven 32, 40
Balfour, Henry 226
  on bamboo strike-a-light 119
  fire thong 106, 110
  lamps collected by 234
Bamboo cooking vessels, Bhutan 45
  lamp frame 232
  portable stove, Chinese 16
  strike-a-light 119

Page
Bamboo strike-a-light, ethnography of 119
  torches of Madagascar 206
  twisted torches, China 206
Bancroft, H. H., observations of 202
Banksia, cone of 4
Bantu, consulting of fire by 182
  southern, myths of 165
Barber, H. Mitford, observations of 25
Bark canoes, steaming and bending, Canada 69
Bark, thickening of 8
  torches, Australia 208
Basket, fire 17
  torch 202
    Borneo 208
    Near East 205
Basutos, bellows of 25
Baths 76
  air, of Pueblos 77
  vapor, among Eskimo 77
    suggestion as to origin 78
Bayberry wax candles 211
Beacons, history of 59
Bear hunting, Natchez Indians 65
Beckwith, Paul, Porto Rico stove 49
Bedouin fire drill 93
Belgium, immigrant lamp of 235
  lamp of 229
Bellows 24
  primitive valve 24
Benares, fire feat at 177
Benefaction myths 161
Berbers, North Africa, fire plow 109
Bernice Pauahi Bishop Museum, Honolulu 234
Bernier, Francois, observations of 7
Bhutan threshing by fire 67
Biblia Pauporum, brazier in 17
Binghamton pattern hot-water foot warmer 16
Biological factor 7
Birch bark roll torches 201
Bock, Carl, observations of 5
Bog fir, torch of 205
Bogle, George, Tibetan fuel 56
Boiling 44
  not known in Homeric age 44
  stone 40
Bokairi Indians, fire myth of 162
Bones of animals used as fuel 57
Bonfires 144
  northern Cheyennes 144
Bonvalot, G., Tibet fire customs 134
Borneo, burning bill in 5
  fire ceremony of 173
  piston bellows of 25
  torches 208
Borrowing fire 166
  tongs for 19
Botocudos Indians, cooking 45
Bourke, John G., Apache talismans 145
Bow and cord drill, Eskimo 96
Bow drill, American Indian 97
  Athapascan 97
Box bellows 25
Boyle, David, canoe making 69
Brass crusies 227
  lucerna, Italy 222, 228

Page
Braziers 62
  ancient, Arizona 27
  antiquity of 28
  Chilean 26
  Indian Hill, Massachusetts, Spanish 26
  Kobatsu, Japan 28
  Mesopotamia, ancient 28
  Mexico 27
  Parsees 28
  Pompeian 26
  Spanish 26
  Tagalog, Philippines 27
Brazil, communal houses of, fireplace in 10
  fire at Easter in 252
  fire-making methods 103
Bribri Indians, genesis myths of 161
Bride's lamp, Eskimo 59
Brinton, Daniel G., observations of 210
British Museum 234, 238
Bronze Age, flat shovel of 20
  pocket stove of 16
Brown, George, observations of 182
  on fire offering 133
Browne, Sir Thomas, on charcoal 76
Brunka Indians, fire myths of 161
Buddha priest, cremation of 169
Buffalo, increase of, cause of 8
Burma, chatty lamp of 232
  fire purification in 173
  oil torches of 208
  torches 208
Burns, treatment of 175
Burrowing animals 7
Bushmen, boiling pot 45
  ceremonial smoking by 176
  exorcism by 183
  fire drill of 92
Busk, or green corn dance 18
Cabeza de Vaca, account of stone boiling 42
Cache, fire, of Creeks 3
  of eastern Indians 3
  of Natchez 3
  of southern Indians 3
California, baking slab 40
  Indians, cremation by 170
Cambodia, wax candles of 251
Camp fires, preservation of 4
Camphene oil fuel 224
Canary Islands, ancient lamps of 244
Candle and torch 198
Candlefish, torches of 200, 201
Candles 209
  dependent on animal and plant resources 209
  development of 208, 209
  dipping of 213
  high in scale of invention 209
  holders 190
    England 215
  kinds of 209
  lanterns 216
  making 211, 212
  molding 213
  placements of, pricket 214

Page

- Candles, placement of, socket 215
  - relative efficiency of 213
- Candlesticks 214
  - Finland 214
  - Germany 215
  - improvements in 215
  - iron 214
  - pricket 214
  - spring 215
  - wooden 214
- Candle wicks 213
- Cane torches 201
- Canoe making by fire 67
  - shaping by fire, Nutka Indians 68
- Cape Finisterre 3
- Carbon dioxide, fatalities from 26
- Caribs, fireplace of 10
  - torches of, Porto Rico 203
- Carmen, Honduras, censer from 23
- Carrier Indians, fireplace of 9
  - kettle of, Canada 115
  - use of spit 53
- Carrying of fire 3
- Casanowicz, I. M., observations of 252
  - on Zoroastrianism 131
- Cashmere, India 7
  - copper-edge wick lamps of 220
  - soapstone lamp of 220
  - vegetal oil in 248
- Cast-iron stoves with grate 49, 50
- Castor-bean oil 248
- Causational myths 160
- Cautery, Thonga, South Africa 79
- Cedar bark, use of as slow matches 3, 4
  - wood torches 201
- Censers, classification of 134, 135
  - primitive pottery 23
- Centennial Exposition, Philadelphia, petroleum lamp exhibited at 224
- Central American tribes, fire origin myths of 161
  - torches of 203
- Ceramics 75
- Ceylon, brass lamps of 231
  - saucer lamps of 231
  - simple lamp of 231
- Chaco Canyon ruins, draught ventilating flue in 23
- Chance ignition 6
- Chanes Indians, fire myth of 162
- Charcoal, discovery of 22
  - Japanese varieties 55
  - use of as fuel 10
    - in braziers 54
- Charlton, E., Auk fuel 57
- Charms against lightning, Thonga 150
- Charred wood, ignition of 4
- Chemical elements as lighting substances 193
  - reactions, fire from xiii
- Cherokee Indians, burial of fire by 3
  - fire offerings 133
  - formulistic name for fire 175
  - lightning struck wood 145
  - parallel fire logs, use of 18

Page

- Cheyenne Indians, fire origin myth of 159
- Child sacrifices 178
- Chile, braziers of 26
- Chimney, antiquity of, in Europe 13
  - in Gloucester County, Virginia 13
  - introduced into America by Spanish 13
  - Powhatan's 13
  - rudiments of 12
- China, bamboo portable stove of 16
  - box bellows of 25
  - feast of lights 254
  - funerary stoves 168
  - joss sticks 4
  - lamps 232
  - red candles of 251
  - saucer lamps 232
  - Western, hand stoves of 16
    - torches of 206
  - white candles of 251
- Chippewa, charms of 182
  - song of the fire 182
- Chiriguanos Indians, fire myth of 162
- Chukchis, Siberia, bow drill 87
  - lamp of 229
  - use of reindeer heat by 2
- Church candlesticks 214
- Chuvanes, Siberia, lamp of 229
  - use of reindeer heat by 2
- Civic lighting 245
- Class, fire as property of 166
- Classification of lighting devices 184
  - of topics relating to fire x
- Clearing and agriculture 65
- Cliff house ruins, trivet bosses of 12
- Coal, bituminous, used by Hopi 57
  - ignition of beds of 5
  - seams, fire produced in xiii
- Coals, walking on burning 177
- Coconut husk, use of in fire preservation 3
  - oil 248
- Cocopa Indians, basket parching 34
  - fire clearing 66
  - sand heating by 15
- Codex Nuttall, fire making in 102
- Codices, pictured torches in 202
- Coiled taper candle of Europe 210
- Colombia, fireplace of 10, 12
- Combustion of slow fire, use of 3
- Communal fire and social organization 165
  - house, a late development 13
  - fires of 9
    - of South America, fireplace of 10
- Concarneau, fishermen of 3
- Conch shell lamps 219
- Conical roof shelter 13
- Consumnes Indians, grasshopper hunt 63
- Contour of the fireplace 11
- Cook, Captain, Australian fire drill 91
- Cook, O.F., on fire clearing by Mayas 67
  - fire plow 108
  - lightning customs 146

Page

- Cooking 30
  - devices, development of 32
  - processes, classification of 31
  - stove, development of 46
  - vessel, Hopi Indians 45
- Copal torches of Venezuela 204
- Copper lanterns 216
- Cord drill, Essen, Hanover 86
  - Poland 86
- Cow dung, use of 10, 11
- Crane 21
- Creek Indians, fire drill 99
  - laying of fire by 18
- Cremation 168
  - causes of 169
  - practices 168
- Crookes, Sir William, letter of 180
- Crucible for melting gold 26
- Crusies 225
  - brass 226, 227
  - hammered iron 227, 235
  - iron 227
  - iron folk lamp 225–228, 235, 236, 242
  - Scotland 225
- Cuba, early torches of 203
- Cuban Indians, fire making 101
- Cult lights 249
- Cult shovel of the Parsee 20
- Curfew, or fire cover 4
- Cushing, Frank H., Zuni cooking 43
  - new fire 140
- Customs and superstitions regarding lightning 144
- Customs connected with the candle 217, 250
- Czaplicka, M. A., Koryak drill 88
- Dall, W. H. 218
- D'Almeida, Javanese fire saw 104
- Dammar gum torches 207
- Danish fire tongs 19
- Davy, Humphry, battery of 244
- Denmark, fire-borrowing tongs 19
  - lamp of 226
- Densmore, Frances, Teton cooking 41
- Development of the cooking stove 46
  - of draught devices 22
  - of fire tools and furnishings of the fireplace 19
  - of the lamp 217
- Devices for regulating the candle 216
  - special, for fire art 14
- Diaz, Bernal, on fireflies 196
- Dipped candles 212
- Disraeli, quotation from xi
- Distillation 72
- Divinatory rite, ordeal at 173
- Dixon, Roland B., observations 162
- Dodge, R., observations 8
- Dogfish tail, torches of 201
- Dogrib Indians, Canada, pyrites used 112
- Domestic animals, warmth utility of 1
- Domestic industries carried on by firelight 190
- Doodoe nut torch of Tahiti 207
- Draught, application of 22
  - classification of 22
  - development of 22

Page

- Draught, induced 22
  - lamps 223
  - natural 22
  - piercing holes for 22
  - ventilation of kiva 23
- Druids' torch 205
- Dung, use of by shepherds 15
- Dutch, immigrant, lamp of 235
- "Dutch oven" 40
- Dyaks, basket torches of 208
  - healing torch of 176
- Earthenware pots, fire storage in 3
- Earthquake, cause of ignition 6
  - fire caused by xiii
- East Africans, exorcism of fire by 184
- East Indies, cast brass lamp of 233
  - rice steaming 43
  - torches of 207
- Eastern Indians, ball racket 19
  - fire log 18
- Edge wick lamps 219
- Egypt, ancient bellows of 24
  - ancient lamp of 238, 239
  - death wake candle 251
- Ehrenreich, Paul 161
- Ehringsdorf man, charcoal found with xii
- Electric lamp 245
  - light 244
- Electricity 193
- Eliot, Charles W., selection of inscription by xi
- England, Argand type lamps 224
  - candle holders 215
  - colonist lamp 235
  - lamp of 224
  - lanterns 216
- Eskimo, broad-wick lamp of 229
  - fire fetish 175
  - fire-origin myth 159
  - Greenland torches 200
  - Icy Cape, cooking 42
  - lamp 234
  - lamp used at feast of dead 250
  - occupation of in winter night 188
  - pottery dish lamp 220
  - torches, Greenland 200
- Ethnography of the bamboo strike-a-light 119
  - of the fire drill 85
  - of the fire piston 109
  - of the fire plow 107
  - of the fire saw 104
  - of the fire thong 106
  - of flint and pyrites 111
  - of flint and steel strike-a-light 114
  - of the lamp 224
  - of tinder 120
- Etruscan stoves 49, 52
- Eubank, Thomas 252
- Europe, age of chimney in 13
  - candlesticks 214
  - fire art in 10
  - fire myths of 162
  - gravity folk lamps 222, 223
  - pricket candlesticks 214
  - torches of 204
- Exorcism practices 183

Page
Extinguishers, candle 217
  wall 205
Fan, application of draught by 22
  blower, invention of 24
  fire 22
Feast of lights 253
Fewkes, J. Walter 203
  on ancient Pueblo fire cult 143
  on Hopi fire priests 131
Fiji fire walk 181
Finland, candlesticks 214
  exorcistic vapor formula 183
  fire-origin myth of 164
Fire alarm, Ainos, Japan 82
    Orokos, Yezo, Japan 82
  alarms and prevention 82
  and light in timekeeping 83
  applied to insect bites 81
  arrows 81
  basket 202
  dogfish as fuel in 202
  bed, raising of 12
  banding of wood, Sioux Indians 69
  borrowing tongs, Denmark 19
  breathing 177
  by friction of landslides xiii
  ceremonies, Hopi Indians 127
  clearing, British Central Africa 66
  clearing in agriculture 65
  collecting termites, Niam-Niam 62
  communal 9
  crackers 254
  drill 105
    Akkadians 86
    ancient references to 85
    Babylonian 86
    Biblical references 86
    Egypt 86
    ethnography of 85
    invention complex 85
    of Western Hemisphere 95
  driving game, American Indians 62
  driving of game, Navajo 61
  fans 22
  flies, Siam 195, 197
  fly lanterns 195
    Java 198
    West Indies 198
  gods 126
    pantheon of 126
  hardened ditches, Arizona 71
  hardening of walls, Troy 71
  hunting 8, 60
  in archeological research 58
  in archeology 58
  in architecture 13
  in decorative art 73
  in marriage customs 153
  in mortuary observances 167
  in nature 5, 6, 7
  in ripening fruit 65
  in war 81
  juggling 176
  keeper, American Indians 132
  location of 8, 14

Page
Fire logging, Southern Indians 67
  towers, Persian 60
  making, Akikuyu 94, 95
  making by artificial means 84
    Central Eskimo 97
    development of 84
    Greenland 97
    physical means of 85
    Point Barrow Eskimo 97
  marriage 155
  mortuary 167
  new 138
  origin myths 156
    classes of 157
  perpetual 142
    philosophy of 142
  pistons 109
    descriptions of 110
    ethnography of 119
    inventions 19
    or syringe, meaning of 110
    place, development of fire tools and furnishings of 190
    range of 110
  plow 107
    discussion of 107
    ethnography of 107
    Samoa 107
  preservation 2
  prevention, methods of 82
  priests 131
    Hopi Indians 131
  proof structures, China 83
  pure and strange 143
  regulations, Laos 83
  resistent pottery vessels 45
  saw 104
    Australia 105
    ethnography of 104
    India 105
    Malaysia 104
    Philippines 104
  scarring or moxa 80
  signaling 60
  stick 18
  temples, Parsee 129
  thong, distribution of 106
    ethnography of 106
  tools, development of 19
  transportation 7
  vomiting 177
  walking 176
    by Langley, S.P 180
  working of stone, remarks on 70
  worship 128
    discussion of 128
Fireless cooker, used by the Jews 44
  people 2
Fishermen, use of fire horn by 3
Fishing, torch used in 206
Fish oil 247

Page

- Fiske, John 27, 202
- Fixed stoves 51
- Flambeau, medieval wax torch 205
- Flemish bucket foot warmer 17
- Flint pyrites, ethnography of 111
- Flint and steel, date of 114
  - Eskimo 115
  - strike-a-light 114
  - strike-a-light, ethnography of 114
  - trade in 115
  - varieties 116
- Flints used in striking sparks by Japanese 183
- Flint workers, England 116
- Float lamp 230, 238
- Floating expiatory lamps 254, 255
- Flue stoves 28
  - and architecture 30
  - fuel economy of 30
  - Roman 28
- Food supply, normal distribution of 31
- Foot stoves of the United States 17
  - of New England 18
  - used at church 18
- Foot warmers 15
  - Chinese 16
  - Flemish 17
  - United States 17
- Forest clearing, Indians of French Guiana 66
- Fork and shovel, one in development 19
- Fox Indians, fire myth of 160
- France, andirons of 20
  - brass foot warmer of 17
  - chauferette 17
  - immigrant lamp from 235
  - lamp of 227
  - landiers 20
  - miner's lamp of 235
- Franklin, Benjamin, discovery of induced draught by 224
  - inventions of stoves by 53
- Frazer, John, Australian fire saw 106
  - Golden Bough 141
  - observations of 165
  - on bonfires 144
  - on perpetual fire 142
- French Guiana Indian grid 33
- Friction matches, made in 1827 124
- Frigid zone, lighting in 188
- Frontier, inventiveness 244
- Frying and baking contrasted 34
- Fuegians, fireplaces of 10
  - hut grouping by 14
  - pyrites used by 113
  - transfer of fire by 7
- Fuel 53
  - ancient methods of preparation of 55
  - animal 57
  - buffalo chips 55
  - discussion of 53
  - dung, used as 55
  - grass used as, China 54
  - Indian tribes use of 54
  - Ladakh and Lahul, India 53
  - modern materials 58
- Fulton, Robert, flint and steel mechanism for bomb 118

Page

- Funeral pile of Sita 178
- Fungus, fire tender 3
- Future of artificial lighting 191
- Gaboon, bellows of 25
- Gas 245
  - as lighting substance 192
  - lighting 245
- Gatschet, A. S., Karankawa fire making 99
- German immigrant, lamp of 236
  - Jews, lamps of 252
- Germany, candlesticks 215
  - lamps of 226
- Ghost dance 160, 161
  - fire making revival 100, 144
- Ghost, destruction of, in cremation 169
  - by hacking and cutting 167
- Gibil, Assyrian fire god 86
- Gilman, D. C. 194
- Gilpin, Edwin, Micmac cooking 41
- Glass, development of 76
- Glazed lamps 229, 230
  - pottery lamps 220, 221
- Gods, fire 126
  - of Navaho Indians 127
- Gran Chaco Indians, fire myth of 162
- Grant, James, Egyptian hieroglyphs 239
- Grape, stones of, oil from 248
- Graph of development of lighting inventions 185
- Grass torches of Australia 208
- Grass, bunches of, fire torches of 15
- Grass fire fan, Jivaro 18
- Grate, antiquity of 21
  - bars 21
- Grate stoves 46, 47, 51
- Gravity pressure lamps 222
- Grease lamp 190
- Greece, fire ordeal of 172
  - lighting in ancient 242
  - pumpkin lantern of 251
  - purification by fire in 174
  - torches in ancient 199
- Green corn dance 18
  - Minitaree Indians 139
- Grenadine art work 229
- Griddle, Mexican 40
  - stone, North African 40
- Gridiron 20
- Grids of the Powhatan Indians, Virginia 33, 36
- Guatuso Indians, Costa Rica, drill 102
- Gypsy burial, property burning with 167
  - iron rod of 21
- Haddon, A. C., Dyak skull cult 134
  - on fire walk 181
- Haida Indians, cremation practices by 170
  - fireplace of 9
  - ideas on fire 132
  - light myths of 256
- Hair cutting by fire, Sioux 73
- Hallstadt period, gridirons of 21
- Hand stoves, of eastern Asia 16
- Hand warmers 15
  - Chinese 16
  - Flemish 17
  - United States 17
- Harvey, E. Newton, 194

Page

- Hassler, Emil, fire making, Brazil 103
- Hawaiian fire myth 164
- Healing by fire, Neolithic age 79
- Healing fire drill 176
  - superstitions 174
  - torch 176
- Heape, Charles 234
- Hearn, Lafcadio, Japanese lighting lore 147
- Hearne, Samuel. Athapascan tinder 121
- Hearth, clay 47
  - sandstone, Hopi Indians 100
- Heating appliances for special uses 14
- Heat, application of in cooking 31
  - cure for toothache, Cherokee Indians 80
  - development in metallurgy 74
  - prediliction for 1
- Hedin, Sven, Mongol trivet 48
  - observations of 16, 174, 183
- Herodotus on Scythian fuel of bones 57
- Hewitt, J. N. B., Iroquois smoke offering 137
  - pump drill 98
- Hibachi smokers, Japan 27
- Hindu, bellows, method of operating 24
  - fire ordeals of 171
  - fire sacrifices by 178
  - multiple light lamps of 253
  - superstitions 183
- History of man and fire, stages in xiv
- Hobbs, J. F., Australian fire saw 106
- Hodge, F. W., Pueblo fire offering 133
- Holland, Brass-spout lamp 229
  - lamps of 229
- Hopi, field ovens 24
  - borrowing of fire by 166
  - fire priests 176
  - fire sticks of 4
  - fire strategy of 82
  - lightning lore 149
  - use of reflected sunlight 252
- Horn and ivory shaping, Indians and Eskimo 70
- Horn, fire, use of 3
- Hot drinks, early use of 1
  - foods, early use of 1
  - springs, New Zealand 1
  - stones, tongs for handling 19
  - water bottles of pottery 16
  - water containers 16
- Hrdlicka, Ales, regarding earliest fire use xii
- Hugham, Robert, Australian drill 91
- Hugo, Victor, Fumade's fire producer 124
- Humboldt, A. von, burning of straw effigies 134
  - observation on fire 1
  - Parsee temples 129
- Hunting with the use of fire 60
- Hut grouping 14
- Hutchin Kutchin Indians, superstition regarding pyromancy 182
- Hyde, John, observations on fire immunity 181
- Hydrogen lighter 125
- Iceland, lamp of 226
- Ignition 5
  - chemical 5
  - dioptric, rare occurrence of 5
  - in nature 5
  - point 4
  - solar, fortuitous 5

Page

- Iles, George, observations of 195
- Illuminants 246
- Illumination 184
- Im Thurn, E., British Guiana Indians 102
- Incense 134
  - burners 23
  - explanation of use 136
  - kinds 137
  - range of custom 134
- India, feast of lights in 177, 254
  - fire drill in 90
  - lamps of 231
  - southern, bellows of 25
- Indian tongs, North America 19
- Indians, British Guiana, fire making 102
  - French Guiana, fumigation against snakes 62
  - of Louisiana, torches of 201
  - of Maine, torches of 201
  - of Mexico, use of insects for lighting 197
- Induced draught 22
- Inscription regarding fire on Union Station xi
- Insect waxes used for candles 212
- Invention, in the fireplace 19
  - stages in the advance of lighting 199
- Ireland, bog fir, splint candles of 210
- Iron Age, gridiron of 21
  - lamps of 220
  - trivet, an introduction of 20
- Iron candlesticks 214
  - gridiron 21
  - lanterns 216
- Iroquois Indians, new fire 138
  - use of simple drill by 98
- Iroquois League, messenger fire 59
- Italian, brass lucerna 222, 228
  - bronze gravity pressure lamp 222
  - copper bucket foot warmer 17
  - lamp 227
  - scaldino or ambulant stove 16
- Japan, bellows 25
  - belly stove 16
  - feast of lanterns 253
  - firefly hunters of 19
  - fire drill of 89
  - fire ordeal in 172
  - fire walking in 180
  - flint used in exorcism in 183
  - kitchen range 52
  - lamps of 233
  - pocket stove 16
  - torches of 206
- Java, firefly lamp from 198
  - fire piston of 110
- Jewish, ancient lamps 241
  - synagogue lamps 239
- Jewett, J. R 35
  - Nutka Indian canoes 68
- Jews, use of funerary candle by 251
- Jivaro Indians, fire logs 18
- John, quotation from 14
- Joss sticks of Chinese 4
- Jungle fires, causes of 6
- Junod, H. A., African fetishes 150
  - on Bantu drill 92
- Juvenal, mention of fireless cooker 44

Page
Kaingang Indians, fire myth of 162
Kalevala, Finnic fire-origin myth 164
Kamtschadales, use of body warmth of dogs by 2
Kane, Elisha Kent, Eskimo use of pyrites 112
Kane, Paul, Chinook fire making 101
Kang, North, Asiatic warming stove 29
Kangri, stove, Kashmir 16
Karankawa Indians, Texas 99
Kashmir, pottery lamps of 231
Keane, A. H., Botocudos 45
Kerosene lamps 224
Kew Gardens, tinder from 119
Khan, Grand, fireplace in tent of 10
Kiowa Indians, sweat lodge 78
Kirk, Edwin, lightning charm, Chinese 151
Kitchen ranges 51, 52
Kiva, ventilation of 23
Klamath Indians, fireplace of 9
Klemm, Eskimo use of bones for fuel 57
Kokona Tanguts, fire altar 132
Korea, fire drill known 90
  lamp of 233
  sacrifice of straw images 133
  soapstone stove of 50
  torches of 206
  Koryak, Siberia, use of drill 88
  Kunze, F., European drill 87
  Kwakiutl Indians, spit for fish 33
  Kyal lamps, Massachusetts 237
  Lacandone Indians, Mexico 23
    fire fagots of 81
Lamp, advanced forms 244
  ancient 239
  Ceylon 231
  China 232
  development of 217
  electric 244
  England 224
  ethnography of 224
  float 230, 238
  Holland 229
  of antiquity 239
  Italy 227
  kerosene 224
  Roman 242
  saucer 219
  shell 219
  used in cult 252
  with beak 220
  wicks 222
  with limited gravity pressure 222
  with wick spouts 221
Landiers of the French 20
Lang, Andrew, observations of 162, 179
Langley, S. P., observations by 179, 198
Lansdell, Henry, Siberian fuel 56
Lanterns, England 216
  firefly 198
  perforated copper 216
Laos, flat lamp of 232
Lapland, torch of 204
Lard oil lamp fuel 224
Latitude, influence on fire art 10, 11
Laufer, B., on Chinese lightning charm 151
  Chinese use of lens 90

Page
Law, primitive substitute for 170
Layard, Henry, fire worship 131
  fuel of Arabs 56
Laying the fire 18
Lazto, Charles, observations of 196
Lens and mirror 119
  for sacred fire, Rome 120
  in fire making 90, 120
Lepcha jewelers, India 25
Lewis, Capt. T. H., fire saw 105
Light and fire in timekeeping 83
Light, cult 249
  electric 244
  gods 256
Light-emitting beetles 196
Lighthouses, ancient 60
  Mexican 60
  oil used in 248
  Vikings 60
Lighting 245
Lighting, cause of ignition 6
  charm, Hopi Indians 151
  civic 245
  customs, Botocudos, South America 151
  customs and superstitions 144
  fire from xiii
  lore, Japan 147
  Mexican beliefs 149
  remarks on 145
Lightning, struck house, ceremony on 150
  superstitions and customs 144
  symbols, Pueblos 149
  Thonga, South Africa 147
Light-producing animals 186
Lillooet Indians, myths regarding light and fire origins 161
Ling Roth, H., on Cuban hearth 101
Link holders 205
Lloyd, T. G. B., Beothuc strike-a-light 112
Location of the fire 8-14
Logs, crossed fire 18
Lowie, R. H., Assiniboines 41
Lucerna, cult lamp 250
  Italian lamp 222, 228
Mackenzie River, lignite beds near 5
Madagascar, iron lamp of 238
Maeva Indians, Venezuela, drill 102
Magi, fire worship of 246
Maidu Indians, fire myth of 159
  fireplace of 9
Makah Indians, fire scarring 80
  location of fireplace of 9
  shell lamps of 219
Malayan bellows, distribution of 25
Malay bamboo strike-a-light 119
  box hearth 11
  fire stones 11
Malaysia, fire drill in 91
Mallery, Garrick, smoke signals 59
Man, E. H., Nicobarese cooking 46
Mandan Indians, crossed fire sticks of 18
Manitous, fire gods 127
Manouvrier, L., healing by fire 29
Man's arts never without fire xiii
Maori, fire myth 162, 163

Page

- Maori, fire superstition of 182
  - oven 37
- Mapuche Indians, fire scarring 80
- Marchand, M., canoe making 68
- Marquesas, nut torches of 207
- Marriage customs, fire in 153
  - Hindu 154, 155
- Matabut Islanders, New Guinea, preservation of fire by 3
- Mataco Indians, fire myth of 162
- Matches 123
  - invented by John Walker 125
  - preliminary invention 124
- Materials for candle making 211
- Matthews, R. H., Australian oven 38
- Matthews, Washington, charcoal making by Navahos 54
- Maya Indians, fire clearing by 66
- Medicine, fire treatment of 175
- Menomini Indians, fire myth of 160
- Mercury arc light 194
- Merriam, C. Hart, California fire myths 158
- Merrill, George P., meteoric iron 114
- Mesa Verde, Colorado, fire temple at 4
- Mesopotamia, lamps of 230
- Metal lamps with gravity pressure 222
- Metallurgy 74
  - blast in 74
  - remarks on 74
- Metal stoves 50
- Meteoric iron, not used in fire making 114
- Mewan Indians, California, ideas of fire 158
- Mexicans, ancient, fire drill of 102
  - bread market of 203
  - consulting of fire by 182
  - new fire ceremony 140
- Mexico, baking 39
  - braziers of 27
  - elaborate fire cult in 126
  - fireplace of 10
  - hot air baths in 77
  - pottery tortilla baker 40
  - tin lamp of 236
  - torches 202
- Mica plates, fire bowl 16
- Micmacs, Nova Scotia, stone boiling 41
- Middle stick 18
- Milinda panha, fire reference 90
- Milk, extinguishes lightning fire 150
- Miller, Gerrit S. 7
- Miller, W. C., mound builders' oven 39
- Mindanao, torches of 208
- Mindeleff, Cosmos, Navaho drill 100
- Mineral, illuminants 246
  - lighting substances 192
  - oil 247
  - substances for candles 212
- Mirror and lens 119
- Mirror for fire not used in America 120
- Moa, of New Zealand 8
- Modification of habits by fire 7
- Mohammedan, art in lamps 230
  - vase-shape lamps 230
- Mohave Indians, dreams regarding fire 184
  - fire myths 160
  - fishhook making 69
  - suggestion of pottery 76

Page

- Moloch, fire god 178
- Mongol shepherds, fire of 15
- Mongolia, torches of 206
- Mongols of Lob Nor, fireplace of 11
- Monongalia County, West Virginia, burning coal seams in 5
- Montagnais, fireplace of 9
- Montaine, Michel de, observations of 166
- Mooney, James, observations of 161
- Moore, Clarence B., observations of 170
- Moorish art in lamps 228, 229
- Morgan, Lewis, pump drill 98
- Morocco, baking slabs 40
  - metal lamps 237
  - pottery lamps 237
  - stoves 50
- Mortillet, A. de, Berber fire plow 109
  - observations of 199
- Morton, Thomas, pyrites, New England 112
- Mortuary observances, fire in 167
- Moses, denouncing of fire walking by 178
- Mosquito Coast 196
- Mosquito lamps, Chinese 62
- Motus, New Guinea, cooking vessels 45
- Moulds for candles 212
- Mound builders, cremation by 170
- Moxa 80
  - a Buddhist rite 81
  - tapers, Korea 81
  - use of 174
- Mussel shell, fire storage in 3
- Mutton fish torch of New Zealand 208
- Mycenae, two-tined copper fork from 19
- Mythopoetic quality, grades of 156
- Myths of the origin of light 255
  - regarding fire 7
- Nansen, F., fuel used by Eskimo 55
- Natchez Indians, cooking by 45
  - fire clearing by 66
  - use of spit and grid 33
- National forests, fire in, causes of 6
- Natural draught 22
  - gas not used for early lighting 245
  - ignition 5
- Navaho Indians, fire dance of 144
  - fireplace of 9
- Near East, fire art in 10
  - lamp of 230
- Needs of preservation of fire 4
- Negritos, Philippines, fire saw 104
- Nelson, E. W., Eskimo drill 96
- Neufchatel Museum, and drill 87
- New England, fishermen, torches of 202
  - Indians, fireplace of 12
  - whalers, torches of 202
- New fire 138
  - Cherokee Indians 139
  - festival, Japan 141
  - M'Bambas, Angola 141
  - Peru 140
  - remarks on 138
  - Thonga, South Africa 141
- New South Wales, natives of 7
- New Zealand 8
  - mutton fish, torch of 208
  - smouldering coal seams in 5
- Night ceremonies dependent on fire 189

Page
Night light 238
Nights, influence of, on lighting inventions 185
Nordenskijold, Baron 87
    on Siberian flint and steel 117
Nordenskijold, Erland, South American fire myths 158
North African lamp 228
North America, torches of 200
Northwest Coast Indian, simple drill 150
    stick tongs of 19
Norton, C. A. Q., observations of 210, 226
Norway, lamp of 226
Nozzle bag bellows 24
Nut oil 248
Oblong structures, origin of 13
Observation, fire invention by xiii
Occupational lamps 225
Oceania, fire myths of 162
Offerings to fire 132
Oil presses 249
Old World ordeals 171
Olive oil as lamp fuel 221, 248
Omaha Indians, lighting customs of 145
Ordeals 170
Organic lighting substances 192
Origin myths 156
Orkney Island lamp 218
Osage Indians, carrying of fire by 3
Osier, woven, fire bowl 16
Outside fireplace 10
Ovens, aboriginal 34
    agave, Mexicans 37
    Biblical 39
    Cora and Huichol Indians, Mexico 39
    erected above ground 39
    Eskimo 37
    Hopi and Zuni Indians 39
    Koitapu natives, New Guinea 45
    Maori, New Zeland 37
    modern Syrian 39
    mound builders, Ohio 39
    Nez Perce Indians 35
    Nutka Sound Indians 35
    paunch, Teton Sioux Indians 41
    pit, Polynesians 38
        Ute Indians 37
    Pomo Indians, California 36
    Powhatan Indians, Virginia 36
    Queensland, Australia 38
    skin-lined pit 41
    Tequila, Mexico 37
    without hot stones 38
    Zuni myth of 39
Pallas, P. S., observations of 6
Palmer, Edward, observations of 15, 19
Palm oil 148
Panamint Indians, nut harvest by fire 66
Papa-Ita, fire walk by 179
Paper cartridges of charcoal 16
    formulistic burning of 175
Paraffin candles 212
    oil lamp fuel 224
Parching and roasting, discusion of 33
Parching in basket 33
Paris, early street lights of 205

Page
Parsee, fire worship of 129, 130, 178
    obtaining of pure fire from lightning by 147
Patagonians, fire making 103
Patwin Indians, Sacramento, fireplace of 9
Peat, Greenland Eskimo use of fuel 57
Pecten-shell lamp of Britany 219
Pennsylvania Germans, fire borrowing by 166
    fire treatment of erysipelas by 175
    iron candlesticks of 214
    tin table lamp 236
Perpetual fire 142
    lights 255
Persia, fireplace 10
    fire purification on New Year's day by 174
    fuel used in 10
    mystic fire of 177
    saucer lamps of 230
Peter, Simon 14
Petroleum, discovery of 224
Philadelphia Centennial Exhibition, hot water containers at 16
Philippine Islands, fire piston of 110
    lamps of 233
    stoves 51
    torches of 207, 208
Phosphorus, discovery of 125
Piercing holes for draught 22
Pile dwellings, lighting of 243
Pima Indians, fireplace of 10
Pine, dissemination of seed by fire 8
    fat, splint torches of 203
    torches 203
Piston bellows 25
Pit house, ancient, at Luna, New Mexico, stone hearth in 12
    fireplace of 10
Plains Indians, drill obsolete 99
    fireplace of 9
Playfair, Lyon, Memoirs and correspondence of 181
Pleyte, on Indonesian fire drill 91
Pocket stove, Japanese 16
Poison in food, extraction by cooking 36, 37
Polo, Marco 246
    fire myths of 162
Polynesia, fire walk in 179
    stone lamps of 234
    torches 207
Pomo fire lifter 19
Portable stoves 47
Porto Rica, stoves of 49
    torches of 203
Portugal, stoves 49
Portuguese immigrant, lamp of 236
Pothooks 21
Pottery, antedates metallurgy 75
    development of 76
    hot-water bottles 16
    stoves 47
    use of, in vessels for boiling 44
Powell, J. W., Ute Indian cooking 37
Powhatan, chimney of 13
Powhatan Indians, Virginia, spits and grids of 20, 33
Prairie, cause of denudation of 7

Page

- Prairie, clearing of, effect on Indian habits 8
  - grass, fire of 8
- Prayer to fire, Nahuatl Indians 127
- Predilliction for heat 1
- Prehistoric America, cremation practices in 180
- Preservation of fire 70
  - of wood by fire, Nicaragua 70
- Preservational myth, Tillamook Indians 158
- Prevention of fire and fire alarms 82
- Pricket candlesticks 214
- Priests 131
- Primates, use of fire by xii
- Primitive circular house 13
- Prince of Wales, fire immersion of 180, 181
- Prometheus theft of fire 162
- Prorok, Byron, Khun de 243
- Proteins, light-emitting 194
- Pueblo Indians, adoption of chimney by 13
  - charcoal in ancient cemeteries of 167
  - cremation practices 170
  - fire tongs 19
  - fireplace of 9
  - kiva of 29
  - stone baking slabs 40
  - use of slow match by 3
- Pump drill 98
  - Eskimo and Chukchi 96
  - Iroquois, probable origin of 98
- Purification 173
  - by fire 173
- Pyrites strike-a-light, Eskimo 112
  - Virginia Indians 111
  - with dead, Han Kutchin Indians 113
- Pyromancy 182
- Quasi-primitive lamps 218
- Queen Charlotte Islands 170
- Queensland aboriginals, wood binding by 70
- Queres Indians, fire cures by 175
- Quinaielt Indians, Washington, fire making by 101
- Rain charm, Santa Barbara Indians 152
  - Thonga, South Africa 152
- Rain making 152
  - fires, Apache Indians 152
- Raleigh expedition 7
- Ramayana 178
- Ranges 51
- Ratchet, extensible 21
- Ravenstein, A. G., on Amur stove 29
- Reactions of animals to artificial light 186
- Reeds, dried, bundles of 11
- Reflectors, candle 215
- Reid, Wemyss, "Memoirs of Lyon Playfair" 181
- Remusat, Abel, on fire purification 173
- Renewal myths 161
- Requirements for improvement in lighting 222
- Reservoir lamp 222
- Resin torch 202, 204, 214
  - of Africa 206
- Retention of heat, objects for 15
- Reygasse, Maurice, Berber fire plow 109
- Rice steaming, East Indies 43
- Rigid candle 210
- Roasting and broiling 33

Page

- Roasting in basket, Ute Indians 73
- Rockhill, W. W., observations of 15, 29, 232
  - on fertilizer preparation 72
  - on flue of Drupa Tibetans 56
  - on Mongol stove 52
  - on tinder in Tibet 123
- Rock oil torch of Burma 208
- Romans, baths of 78
  - candles of 210
  - hot-water container of 16
  - lamps of 242
  - sacred fire of 178
  - use of seed oil by 248
- Rope torch 204, 205
- Roth, Walter E., Queensland oven 38
- Rubruquis, William de 10
- Rudimentary oven 12
- Rudiments of invention in the fireplace 11
  - Eastern Asia 210
- Rush candle of northern Europe 210
- Rush clip handle holders 210
- Russia, trans-Ural 5
- Russian flue stove 29
  - lamp used in funeral processions 251
  - taper holder 214
- Sable antelope, use of 25
- Sacred fire, for incense 136
  - of Muskogi Indians 18
  - of the Parsee 20
- Sacrificial burning 133, 167
- Sakai, fire logs used by 11
- Salish Indians, fire scarring 80
- Salt River valley, Arizona, ditches 71
- Sanitation 79
  - of ancient Greeks 29
- San Juan ruins, ventilating flue of 23
- Santa Barbara, California, ancient baking slabs 40
- Santa Rita Mountains, Arizona 6
- Saracen type beak lamps 220
- Saucer float lamps 238
- Saucer lamps 219
  - Ceylon 231
  - China 232
  - of pottery 231
  - primitive 219
- Scaldino, or ambulant stove 16
- Scandinavian fire burial 168
- Schliemann, Henry, on ancient burial practices 168
  - on fire burnt walls 71
  - on funerary fire fork 19
- Scidmore, E. R. 198
- Scotland, extemporized lights 205
  - hammered iron crusie 225
  - lamp of 225
- Sea-shell lamps 218
- Seal oil 247
- Sha-lo, of western China 16
- Shangaris, bellows of the 25
- Sheet iron torch base 202
- Shell lamps 218
- Shetland Islands, shell lamp of 218
  - torches of 204
- Shield, candle 215

Page

Shom Pen, Nicobar Islands, boiling 46
Shoshone Indians, fire offerings of 133
Shovel, fire 19
Sia Indians, fire invocation of 173
Siam, fireflies of 197
  torches of 207
Siberia, destruction of ghosts in 169
  flint and steel pyromancy in 182
  tribes of 169
Side draught holes 23
Signals by beacons, history of 60
  fire and smoke 58
  smoke 58
Sikkim, India, blast apparatus from 25
Singapore, torches from 207
Sioux lodge, description of 9
Skin bag bellows 24
Skull cult, Dyaks 134
Slow match 3
Smith, John 7
  on fire making 98
  on native gridiron 20
Smoke and ashes, uses of 71
Smoke and fire signals 58
Smoke, attitude of primitive peoples toward 13
  fumigation, Eskimo 29
  hole 9, 13
  lore of 136
Smudge for insects, Chukchi 61
  Lapps 61
  Tunicas and Creek Indians 61
Snuffers, candle 216
Soaproot, baked in oven 36
Soapstone, cooking pots, Eskimo 44
  lamps, Cashmere 220
  stoves, Korea 50
  triangular lamps, Turkestan 230
  use of, in baking 34
  use of, in boiling vessels 44
Social organization and communal fire 9
Society Islands, baked candlenut of 207
Sockets for burning candle ends 215
Sob, Pom K., Korean lighting customs 147
Soho candle lamps 213
Solomon Islands, fireplace in dwellings of 11
  fire plow of 108
Soumoos Indians, Nicaragua, cooking by 45
South America, fire-origin myths of 161
  torches of 203
Southern Indians, cross-shape religious fire 18
Spain, braziers 26
  fire blowing tube from 19, 20
  lamp of 228
  scissor-like tongs of 19
  stoves 49
  torches 205
Spanish immigrant, lamp of 236
  obsolete lighting devices 205
  shovel for tending brazier 20
Special heating appliances 14
Spectrum analysis of light 194
Sperm oil 248
Spider, cast iron 40
Spirit, or expiatory lights 254

Page

Spit, of Powhatan Indians, Virginia 33
  primitive 33
Splint holders 214
Spontaneous combustion of coal dust 5
Spout, long, lamps of Northern Europe 222
Spring candlesticks, Germany 215
Srinagar, Kashmir, stove of 16
Starr, Frederick, Batua fire plow 109
Stationary fireplace 21
Steamer for rice, East Sumatra 43
  Simalur Island 43
Steaming, rice 43
  Zuni Indians, method of 43
Steel, introduction of 114
Stone age, torches of 199
Stone baking slabs 40
Stone boiling 40
  Arikara Indians 42
  Dogrib and Slave Indians 42
  East Canadian Indians 41
  Hong Kutchin Indians, Canada 42
  Indians of lower Rio Grande 42
  Kwakiutl Indians 42
  modern practice 43
  Solomon Islands 43
  Teton Sioux 41
  Tlingit Indians 42
  vessels used in 41
  Zuni Indians 42
Stone, bosses, bordering circle of 12
  fireplace of 12
Stormy petrel torch 204
Stove, additions to 52
  African 48, 51
  ambulant 16
  ancient Etruscan 49, 52
  bosses of 20
  cast iron, with grate 49, 50, 51
  cooking, development of 31, 32
  earth, Africa 51
  Etruscan 49, 52
  fixed 51
  flue 28
  hand 16
  Hindu, in South Kensington Museum 48
  hot water, Chinese 50
  inventions in 49
  metal 49
  modern and ancient Egypt 48
  portable 47
  Portugal 49
  pottery 47, 48, 49
  simple 47
  simple range, Philippines 51
  simple, with hearth 47
  soapstone 34
  under draught 49
  West Indies 49
  with grates 46, 47, 51
  without draught 47
Strange and pure fire 143
Strange fire, Biblical reference 143
Street lighting 245, 246
Strike-a-light, Africa 118

Page
Strike-a-light, bamboo, ethnography of 119
  Chinese 119
  discussion of 111
  flint and steel, ethnography of 114
Strung nut torches 207
Sudanese, wheel and crank drill 92
Sunning process in preserving food 44
Superstitions and customs regarding lightning 144
Superstitious healing 174
Swan, J. G., Makah Indian 219
Sweat bath as therapeutic agent 78
  stones from 19
Sweat house, Shuswaps 78
Sweden, lamp of 226
Tahiti, fire walk at 179
Taiyals, Formosa, new fire 141
Taper candle 209
Tapiete Indians, fire myth of 162
Tapuyos Indians, beeswax and bark tapers of 210
Tar and resins from fire 72
Tartar purification customs 173
Tasmanians, fire drill 91
  fire plow 108
Tattooing by fire, Philippines 80
Technology 67
Tehuelche Indians, carrying of fire by 3
Teit, James 14
Temezcal, vapor bath, Mexicans 77
Temescalli resembling oven 39
Temperate zone, lighting in 186
Temple fire at Mesa Verde 4
  fire walking 180
Ternate, dammar-gum torch of 207
Terra cotta gravity pressure lamp 222
Terra cotta pocket stove 16
Teton Sioux, fire song of 160
Tewa Indians, fire shamans of 175
Theft of fire 159
Theodore, Emperor, fire iron ordeal of 172
Thompson River Indians 14
Thotmes III 24
Threshing by fire 67
Thunderbird and lightning 149
Tibet, butter lamp of 232
  feast of lamps in 254
  fire ordeal in 172
  fire purification in 174
  torches of 206
  stoves 52
Tile flue stoves of North Europe 29
Tilting crusie 237
Time by light and fire 83
Tinder, ethnography of 120–123
  pistol 118
  wheel 118
Tinne Indians, drill of 98
Tlelding Indians, California, oven of 4, 36
Tokyo, Ontake Temple at 180
Tongarioo, eruption of 8
Tongs, American Indian 19
  bronze fire, Danish 19, 166
  crotch-stick 19
  fire 19
  fire borrowing 166
  Spanish pincer 19

Page
Tools, sticks as first fire 19
Tools and furnishings of the fireplace 190
Top log 18
Torch and candle 198
  at funeral rites 250
Torch chandelier of Simalur Island 208
Torches 198
  Africa 206
  Borneo 208
  Burma 208
  healing 176
  lower Siam 207
  Mexico 202
  Mongolia 206
  Philippines 207, 208
  resin 202, 204, 214
  Singapore 207
  Spain 205
  Virginia 210
  West Africa 106
  West Indies 203
Torch fishing 64
  hunting, Indians 64
"Torching" geese, Nutka Indians 64
Torch material 199
  stand 190, 214
Torday on the Bahuana, Africa 146
Tozzer, A. F., Lacandon incense 23, 137
Tradescant Musem, Oxford 15
Transportation of fire 7
Trap, channel for fire xiii
Tree, hollowed, fire storage in 3
Tripod cooking place, Luna, New Mexico 40
Trivet 26
  bosses of baked clay 12
Tropical lamps, undifferentiated 186
Tropics, lighting in 187
Tube blower 24
  fire blowing 19
Tubular wicks 223, 224
Tulolome Indians, Rogue River, Oregon, fireplace of 9
Tupi fire myth 162
Turkestan, exorcism in 183
  lamps of 230
Turner, George, New Caledonia, canoe making 68
Tuski, Siberia, fire drill 88
Tylor, E. B 237
  on fire worship 126
  on primitive culture 43
  remarks on flint and steel 118
Uintah Ute Indians, coyote and fire origin 161
United States, kerosene lamps of 224
Ute Indians, fireplace of 9
Utilization of fire, earlier steps in xi, xiii
Valve and valveless bellows 25
Vapor bath, American tribes 77
  Romans 77
Vases for cremation ashes 170
Veddas, Ceylon, fire drill 90
Vegetal materials, easy in ignition 4
  oils 248
Ventilation in fire storage 3
Verner, S. P., Baluba, Africa, bark vessels 46

Page

- Very, F. W. 198
- Vesta, temple of 165
- Viking ship, oak candlestick of 214
- Virginia Indians 20
  - fire scarring by 80
  - transportation of fire by 7
- Virginia, spit and grid of Powhatan Indians 33
  - taper candles of 210
  - torches 210
- Volcanoes, fire from xiii
- Wa Chaga, East Africa fire arrows 81
- Walker, John, inventor of friction match 124
- Wallace, Alfred Russell, observations of 207
  - on bamboo 119
  - on fire saw 104
- Walnut oil 248
- War 81
- Warmers 15
  - foot 16
  - hand 17
- Warming of habitations 14
- Washington, George, Argand lamp of 223
  - candlestick of 215
- Water and fire xi
- Wax candles 211
- Weapon fire, magical 159
- West Africa, torches of 206
- West Indies, firefly lantern from 198
  - stoves 49
  - torches of 203
- West Virginia, fire timbering in 67

Page

- Whale oil lamp fuel 223
- White, John, drawing by 20
  - fire depicted by 7
  - on Virginia Indians 33
- White Mountain Apache Reservation 6
- Wick, developement of 208
- Wicks 222
- Wilkes, Charles, observations by 7
- Williams, Matthieu, observations of 209
- Williams, Roger, Connecticut Indians 98
- Williams, Talcott 48, 49, 237
- Willoughby, C., observations of 26
  - on pyrites in graves 112
- Windbag 25
- Windbreak for fireplace 10
- Wind-incited friction, fire from xiii
- Woman, attendant of fireplace 11
- Wooden tongs. ancient, in Utah 19
- Wood, quantity of used in fire 9
- Woodrow Wilson xi
- Woodthorpe, R. G., observations of 6
- Woodworking by fire, northwest coast Indians 68
- Worship by fire 128
- Xenophon, fire signals of Kurds 59
- Yakgan, conical wigwams, fireplace of 10
- Yarchans, fire superstition of 175
- Yarrow, H. C., observations of 167
- Yezidis, fire worshippers 131
  - torches of 202
- Yurok Indians, California; heated earth oven 39
- Zoroaster 130

SMITHSONIAN INSTITUTION LIBRARIES
3 9088 01421 2187